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ON DISORDERS OF
ASSIMILATION, DIGESTION, ETC.

GOUT, FROM HOGARTH'S 'MARRIAGE À LA MODE' (*vide* p. 130). [*Frontispiece.*

ON DISORDERS

OF

ASSIMILATION, DIGESTION,

ETC.

BY

SIR LAUDER BRUNTON,

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London

MACMILLAN AND CO., Limited

NEW YORK: THE MACMILLAN COMPANY

1904

First Edition, 1901.
Reprinted, 1904.

To

WILLY KÜHNE

PROFESSOR OF PHYSIOLOGY IN THE UNIVERSITY OF HEIDELBERG,

MY TEACHER AND FRIEND,

This Book

SHOULD HAVE BEEN DEDICATED WITH HIS PERMISSION HAD HE LIVED.

NOW, ALAS! I CAN ONLY DEDICATE IT TO HIS MEMORY.

PREFACE

Like its predecessor, *Disorders of Digestion*, this book is a collection of scattered papers and addresses, written at various times and delivered on various occasions. At first I intended to incorporate some of them in a new edition of *Disorders of Digestion*, and issue them also separately as a supplement, which those who already possessed the first edition might buy separately. Indeed, this second edition and supplement were already advertised, when I found that the papers I wished to reprint were so numerous as to form a second volume as large as the first. I then thought of publishing them under the title of *Disorders of Digestion, Second Series*, but the probability of confusion between the two different books with such similar names determined me to issue it under the present title. As the papers it contains were addressed to different sets of readers or to different audiences, there is a good deal of repetition, and I can only plead in excuse, as I did for the same fault in *Disorders of Digestion*, that the same ideas recur again and again because they have assumed great importance in my own mind, and therefore I wish to impress them on others. More especially is the action of ferments or enzymes as agents in the production of tissue-metabolism referred to again and again; and, indeed, my work in the department of physiological chemistry, scientific and practical, has been chiefly directed to the purpose of investigating and expounding their manifold action, not only in the processes of digestion, but of assimilation, tissue-metabolism, organotherapy, the formation of toxins or antitoxins, and of immunity. The address I gave at Moscow gives a general account of the subject, and forms an introduction to the subsequent papers, but it is necessarily very brief, and a few words on the scope of some of the papers may be useful to help the reader. The paper on diabetes gives an account of what I believe to be the first

attempt to show that solid organs other than secreting glands contain a ferment, or, as it is now called, an enzyme, by the action of which tissue-metabolism within the body is carried on. This paper also describes what I believe to be the first attempt at rational organotherapy or opotherapy, a mode of treatment which has become of great importance since 1889, when Brown-Séquard advocated it in regard to the testicle. Since then George Murray, Victor Horsley, and Hector Mackenzie have used it with great success in regard to the thyroid gland. To those who like to follow the evolution of ideas, it may be interesting to note that Claude Bernard was the first to observe internal secretion in the case of the glycogenic function of the liver. It was while working in Bernard's laboratory that Kühne's attention was specially directed to this function, and also to the ferments of the pancreas. It was Kühne who awakened my interest in both these subjects, and instructed me in the methods of experiment, with the result that I employed a new method of treatment—organotherapy. But my attempt was unsuccessful, and though I believe it to be the first in time, yet it was Bernard's successor, Brown-Séquard, who actually succeeded in bringing the method into vogue. How far he was indebted to Bernard it is difficult to say, for though he started from a different point, yet it is impossible to deal with the problem of internal secretion and tissue change without recurring consciously or unconsciously to Bernard's work. So great was the veneration in which Kühne held Bernard and his work, that in making these remarks I am sure that I am fulfilling what would have been his desire. The paper upon the action of alcohol on proteids with Dr. Sidney Martin was intended to be the first of a series on the action of alcohol and other drugs on the proteids, fats, and other constituents of the body, so as to obtain a knowledge of the pharmacology of the cell, as well as of the tissues and organs. The joint paper on the ferment-action of bacteria with Dr. Macfadyen was intended to discover whether the digestive functions of individual cells, such as bacilli, were not much the same in kind as those of higher organisms, and to bring the decomposition of albuminous and other bodies by them into line with digestion in the intestinal tract of higher organisms, where the decomposition of food is affected by enzymes, which will continue to act after their complete isolation from the organism that has produced them.

The fact that such digestion actually does occur, and the observation that microbes have the power of modifying the enzymes they produce in accordance with the media upon which they grow, appear to afford an indication that the phenomenon of infective disease and microbes are due to digestion within the tissues by the enzymes formed by microbes. Further, that the increasing virulence of microbes growing in favourable media is due to an increased power of producing enzymes, whilst the acquired resistance of the tissues is probably due to an extension to them of the power of resistance to toxic substances naturally possessed by the intestine and liver. The paper on atropine in cholera shows the practical result of an attempt to cure infective disease by the use of an alkaloid antagonistic to one which, as I pointed out twenty-five years ago, could produce symptoms similar to the disease, and which alkaloid has now been shown to be a common product of the bacterial decomposition of proteid substances. With the assistance of Dr. Rhodes, I again took up the question of glycolytic enzyme in muscle, and we have been able to confirm my earlier results by more perfect experiments, but we have not yet succeeded in isolating this enzyme. The clumping of bacilli as a question of re-action is interesting both theoretically and practically. Most of the other papers are clinical and practical in character.

Had time and opportunity permitted, I should have liked to combine these fragmentary researches into a coherent whole by other experiments, but other demands upon my time prevent my doing more than collecting them into one book from the scattered publications in which they have appeared. The leading idea of many of them is the action of enzymes, and the recognition of their importance I owe to my teacher and friend, Professor Kühne, who impressed it upon me both by his lectures and conversation when I was working in his laboratory in Amsterdam in 1868–69. At that time he had clearly grasped the idea not only of enzymes, but of zymogens, and stated that both in the stomach and pancreas substances existed, which, though not themselves enzymes or ferments, were capable of yielding active ferments. How much I owe to his teaching it is impossible for me to express, and although the world at large must mourn his loss, only those who knew intimately his person and work know how great that loss is.

It gives me great pleasure to acknowledge my obligations and

express my thanks to my friends, Professors Cash, Allan Macfadyen Sidney Martin, Tunnicliffe, and Watson Cheyne, and to my colleagues, D'Arcy Power, A. Bowlby, and J. H. Rhodes, for their kindness in allowing our joint papers to appear in this collection. I have also to acknowledge my obligations to the Council of the Royal Society for permission to reprint the paper on the presence of a glycolytic enzyme in muscle.

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ADDRESS ON THE RELATIONSHIP OF PHYSIOLOGY, PHARMACOLOGY, PATHOLOGY AND PRACTICAL MEDICINE.

Delivered at the International Congress in Moscow, on August 19, 1897.

THE desire for knowledge which is common to the lower animals and man, savage or civilised, and has induced members of this Congress to come from the ends of the earth in order to gain information, must have led primitive man from the earliest times to study the great problems of physiology, the nature of life, of growth, of reproduction, and of death, as well as to notice the connection of the latter with mechanical injuries, such as the wounds inflicted by clubs and spears or by the teeth and claws of wild beasts.

Next to the problems of physiology come those of pharmacology, by which I mean the poisonous or remedial action of various substances, mineral, vegetable, or animal. A knowledge of this subject is found even amongst the lowest savages, and is of the greatest use to them, for it enables them, on the one hand, to avoid eating things which may cause discomfort, pain, or death, and, on the other, to obtain food by poisoning waters and thus catching fish, or by poisoning their arrows to kill game which would otherwise escape. Closely associated with the knowledge of the poisonous is that of the curative powers of herbs, and it is possessed by animals as well as man, for cows avoid noxious plants, and dogs will every now and again eat grass apparently as medicine. Primitive peoples use various substances as remedies in disease, with more or less success, and one of the most extraordinary points in their practice is that they seem to some extent to have forestalled the newest researches on venins, anti-venins, and organotherapy, for in Africa the Bushmen are accustomed to drink the

poison of venomous snakes as a prophylactic against their bite, and the Hausas prevent hydrophobia by killing mad dogs and making the men they have bitten eat their livers.

The occurrence of death from wounds or poison is intelligible even to a savage, but when illness and death occur independently of these, men naturally attribute them to invisible powers. Thus the Dyaks of Borneo ascribe sickness to wounds from invisible spears wielded by invisible spirits, and during an epidemic of disease in the Middle Ages the cry often arose that the wells had been poisoned. These crude ideas contain germs of truth, and when we look at Professor Metschnikoff's drawings of a Daphnia attacked by a Monospora we seem to recognise the invisible darts of the Dyaks, while during an epidemic of typhoid fever we have often to acknowledge that our wells have been poisoned by bacilli.

It is impossible to trace the steps by which the crude ideas of savage peoples regarding physiology, pharmacology, and pathology have grown into definite sciences, nor even to indicate the most important landmarks, though we naturally think of the names of Alkmaon, Galen, and Harvey in physiology ; of Nicander, Magendie, and Bernard in pharmacology; and of Morgagni, Virchow, and Pasteur in pathology. During this century these three sciences have developed with almost incredible rapidity, a complete knowledge of them is enough to tax severely the most retentive memory, and it is almost impossible for any individual to keep up with the advance of all three of them.

But just as the whole subject of astronomy became suddenly simplified by a change of standpoint at the very time when cycles and epi-cycles became most bewildering, so at the very time when these three sciences are becoming most complex and diverse they appear to be tending to unification and simplification. Pathology, for example, is now becoming to a great extent a branch of pharmacology, for while a few years ago its chief object was to discover, examine, and classify the microbes which give rise to disease, it is now striving rather to discover the nature and actions of the ferments and poisons which they form, and by which they are able to cause disease and death in the animals they attack. Pharmacological investigation, instead of being confined to the alkaloids and other poisons formed by higher plants, has now extended to those formed by microscopic plants, or microbes, and thus comes to include a great part of pathology.

In the same way, though pharmacology is a branch of physiology, inasmuch as it deals with the phenomena of life as modified by drugs, yet physiology may, to a certain extent, be regarded as a branch of pharmacology, because some of the latest researches regarding the processes of life have been made by pharmacological methods, using the products of animal life instead of vegetable poisons. Amongst the pioneers in this line I may mention my two masters, Kühne and Ludwig; the former of whom by his chemical investigations has enabled us to differentiate the various products of albuminous decomposition, whilst the latter, with his pupils Schmidt-Mühlheim and Wooldridge, discovered the poisonous action of albumoses and peptones, and of the juices of various tissues when injected directly into the blood.

Before the proteid constituents of our food can be absorbed they must be split up during digestion into albumoses and peptones; yet these researches show that the very substances which are necessary to repair waste and are indispensable for the continuance of life, prove fatal when introduced into the body in a wrong way, or in too great quantity. But the products of the digestion of albumin do not normally enter the circulation as albumoses and peptones. During absorption they undergo changes of a synthetic nature in the walls of the intestine, and probably to a certain extent also in the liver, so that they again form harmless substances, and their poisonous properties are destroyed before they enter the general blood stream.

But how is it that the ferments which decompose albuminous food and form poisons from it in the intestine do not themselves pass into the blood and kill the animal by digesting the tissues and forming poisons from them? Of course pepsin cannot do so as it only acts in an acid medium, but there is no such hindrance to the action of trypsin, and yet it does not destroy the tissues composing the body itself. In all probability the reason why digestive ferments do not digest the tissues is not that they are destroyed in the digestive canal, nor yet that they are not absorbed, but that they are altered from active enzymes into inert zymogens which can be stored up without risk, and can again liberate active enzymes when these are required to digest a subsequent meal. In this respect they may be compared to the knives used by wandering peoples to cut up their meat, and which are not thrown away after each meal, but are simply put into sheaths which cover their edges and deprive them for a time of their cutting power.

But it is not in the intestine only that enzymes are found, they are also poured into the blood by the pancreas and probably by the thyroid and other glands. As our acquaintance with the processes of cell life increases it seems more and more likely that the tissue change on which functional activity depends is affected by enzymes, and the truer does the speculation of Van Helmont—that life is a process of fermentation—appear to be.

There can be little doubt that if enzymes in a free state were to circulate through the body they would do much harm, and indeed we may regard this as well-nigh proved in regard to the enzyme of tetanus.

But their action is limited either by their conversion into zymogens or their localisation to the cells or tissues where their action is required. This is more readily seen in plants than in animals, and one of the best examples of it is that in germinating wheat.

In the ordinary state of the grain the diastatic ferment is kept apart from the starch by a small layer of cellulose, through which the diastase cannot pass, but during germination another ferment appears which has the power of dissolving cellulose, and by breaking down this dividing membrane it allows the diastatic ferment to act upon the starch, and renders it available for the needs of the growing plant.

Enzymes appear to differ amongst themselves nearly as much as albumin, albumoses, and peptones. Some are easily separated from the cells in which they exist, whilst others are so closely united to the protoplasm that their separate existence apart from it has been denied. The yeast plant, for example, yields an invert enzyme which can be extracted with comparative ease, but the enzyme which splits up sugar into alcohol and carbonic acid is so firmly attached to the protoplasm of the cell that it is only within the last few months that it has been isolated by Buchner by the application of enormous pressure. It is probable that the enzymes contained in the cells of animal tissues differ in like manner, and that by the use of similar methods we may obtain a number of enzymes with which we are at present unacquainted.

But it is not merely the products formed in the digestive canal, or in the organs of animals during life, nor even the alkaloids that are formed by the higher plants, that act as poisons. The processes of life are much the same in the lowest microbes as in animals, or in the higher plants, and these microbes, by forming

ferments and poisons, give rise to disturbance of function or death in animals. When grown in suitable media outside the body they produce enzymes and poisons, albumoses and alkaloids, and many of them continue to do so after their introduction into the body.

One of the most curious points, both in the chemistry of the higher plants and of microbes, is that they tend to form at the same time a poison and its antidote. In Calabar bean, for example, we find there are two poisons—physostigmine and calabarine, the former tending to paralyse the spinal cord and the latter to stimulate it, so that each poison to a certain extent antagonises the other. The same condition is found even more markedly in jaborandi, of which the two alkaloids pilocarpine and jaborine antagonise one another's action, so that, although pilocarpine generally greatly predominates, it might be possible to get a specimen of the leaf having no action at all although it contained a quantity of alkaloids.

When injected into animals the toxins formed by microbes and the venins of serpents cause the production of anti-toxins and anti-venins which neutralise their action, apparently by chemical combination in somewhat the same way as an acid and alkali, each poisonous by itself, combine to form a comparatively inert salt. But the two components here, like an organic acid and a mineral base, are unequally affected by destructive agencies, and the anti-venin may be destroyed, so that the venin again regains its activity.

The conversion of zymogens into enzymes may be compared to the freeing of venins from their compounds, while the conversion of active venins into inert bodies by combination with anti-venins suggests that a similar process may occur in the case of active enzymes, by which they may be converted into inactive zymogens.

Perhaps the hypothesis I mentioned eight years ago to my pupil and friend, Mr. Hankin,[1] that the germicidal power of organisms is proportional to their power to produce enzymes, may not be altogether unfounded, and possibly we may discover also that *immunity, natural or acquired, is nothing more than an extension to the cells of the tissues generally of a power which is constantly exercised during digestion by those of the intestine and liver.*

[1] Quoted by Hankin, *Proc. of the Cambridge Philosophical Soc.*, vol. vii., pt. I. p. 20. Nov. 11, 1889.

This problem is one which pertains to all three sciences, and has a most important bearing on practical medicine.

Practical medicine, except when empirical, depends for its advance on physiology, pharmacology, and pathology. A knowledge of the physiology of digestion has led to the satisfactory treatment of dyspepsia by the administration of digestive enzymes, and pharmacological research has enabled us to treat diseases of the circulation with a success previously undreamt of, by teaching us not only how to use aright old remedies, such as digitalis, but also how to apply new ones, such as strophanthus and amyl nitrite, and even to manufacture others, such as nitroerythrol, which possess the special actions we desire, and are lacking in the drugs we already have. Indeed new remedies, which shall alter tissue change, lower temperature, relieve pain, and procure sleep, are now being made in such numbers that it is hard to keep count of them.

But amongst all the new gains of practical medicine none are so remarkable as those which we owe to pathology. Time would fail me to speak of the prevention and cure of zymotic diseases, but no less astonishing is the discovery that myxœdema depends on inactivity or absence of the thyroid gland, and can be cured by the administration of its extract, which seems to act as an enzyme on living tissues, so that the heavy, shapeless features of the patient resume their natural expression, and the sluggish mental processes become quickened. An exhaustive study of enzymes and their products appears to be the most promising way of advancing our knowledge both of the nature and treatment of disease. Probably more is to be hoped for from an investigation into the nature and properties of those enzymes which are intimately associated with the protoplasm of the cells in the various tissues and organs than even of those which are poured into the blood by glands having an internal secretion, such as the thyroid. For all organs, even those which like muscles and nerves are not glandular, have an action on the blood comparable to that which the yeast plant has on the fluid in which it lives, in modifying its composition by the substances which it removes from, or adds to it. It is to a knowledge of the processes which occur in the protoplasm of the cells in the intestinal wall and liver, and of the enzymes by which these processes are in all probability carried out, that we must look for an explanation of the conversion of the poisonous albumoses formed during digestion into innocuous albumins, and of dangerous enzymes into harmless zymogens.

Moreover, it seems to me that it is by researches into the nature and action of the enzymes not only of microbes, but of the various tissues of the body in higher animals, that we shall learn how the microbes, like the enzymes of the intestinal canal, produce poisonous albumoses, and how the tissues, like the cells of the intestinal walls or liver, convert them into harmless or even protective substances. In this way we may hope to obtain an explanation of toxins and anti-toxins, of pathogenesis and immunity, as well as of the nature of diseases unconnected with the presence of microbes, such as diabetes. Twenty-three years ago I attempted to obtain a glycolytic enzyme from muscle, in order to enable diabetic patients to utilise the sugar in their blood. My attempt was unsuccessful, but we may still hope that by other methods we may obtain from animal organs various enzymes, the administration of which may prove as useful in other diseases as the thyroid in myxœdema.

Practical medicine depends on physiology, pharmacology, and pathology, but all three are tending to become more and more sub-divisions of the wider and all-embracing science of chemistry. It is to a chemist, Pasteur, that we owe the wonderful development of pathology within the last quarter of a century, and we may fairly regard his fellow-countryman, Lavoisier, as the founder of this science. Men from all countries, and especially from Germany, have aided its development; but it seems fitting that at this Congress, in acknowledging our obligations to this science, we should not omit to mention that at its head now stands a Russian, Mendeleef, whose marvellous prescience enabled him to predict the existence of elements which were then unknown, and even to describe their properties more correctly than those who first verified his predictions by obtaining the substances themselves. When we consider that little more than a hundred years have elapsed since the time of Lavoisier, and contemplate the vast benefits which medicine and its allied sciences have derived from chemistry during this time, our hopes cannot be otherwise than great for the centuries to come.

ON A PROBABLE GLYCOLYTIC FERMENT IN MUSCLE AND ON RAW MEAT IN THE TREATMENT OF DIABETES.

Zeitschrift für Biologie, N. F., Bd. xvi. 1897. Jubelband zu Ehren von W. Kühne, p. 487.

DURING the time that I was working with Professor Kühne in Amsterdam, in the Winter Session of 1868-69, he desired me to examine a specimen of urine for inosite. He wanted me to do this both on account of the practice it would give me in testing for the substance, and on account of the interest of the case, for in this patient inosituria alternated with glycosuria.

My interest in the subject of glycosuria and diabetes was thus aroused, and at the same time Professor Kühne directed my attention in a very special manner to the action of ferments. More especially he laid stress in his Lectures upon the presence of ferments in the body, not in a free condition, but in that of ferment-yielding substances. He mentioned that Corvisart in his observations on the pancreas had met with great difficulties in obtaining a gland which would digest proteids. Very large numbers of those which were got in the market proved to be inactive, and it was only after long inquiry that Corvisart discovered the cause of their inactivity, and ascertained that only the pancreas of an animal which had been killed during digestion was capable of digesting proteids. In his Lectures in 1868-69 Professor Kühne mentioned that the inactive pancreas could be rendered active by treating it with dilute hydrochloric acid, which apparently split up the ferment-giving substances and formed a free ferment.

These experiments led me to consider that probably a similar ferment-yielding substance might exist in the muscles, which being split up during muscular exertion might transform any glycogen present there into sugar. At the same time it seemed

possible that another similar substance might exist in the muscles which would yield a ferment causing the further transformation of sugar into lactic acid.

In the succeeding winter, 1869-70, I was working under Professor Ludwig at Leipzig, and at that time he and his pupil Genersich were engaged in ascertaining the changes undergone by various organic substances when mixed with the blood and caused to circulate artificially through the muscles. Their experiments as well as those of Ludwig and Scheremetjewski[1] showed that glucose did not undergo combustion in the blood as such, but that lactic acid and other organic acids, when combined with soda underwent combustion readily. Now Bernard had discovered that as sugar disappears from the blood its place is taken by lactic acid, and that dead muscles not only become acid at the expense of the sugar and glycogen they contain, but cause the formation of acid in a solution of grape sugar to which they are added. It seemed therefore probable that sugar in the living body was converted into lactic acid before undergoing combustion by means of a ferment, and while engaged in writing the Section on Digestion and Secretion in Sanderson's Handbook for the Physiological Laboratory I made many attempts to isolate a ferment from muscle. I succeeded in obtaining from muscles finely chopped up and treated with glycerine, a glycerine solution, which had a slight power of producing acid when added to a solution of glucose, but I was quite unable to isolate any distinct ferment. It seemed probable, however, that the glycosuria in many cases of diabetes might depend upon the non-conversion of glucose into lactic acid, and it occurred to me that possibly, either by giving raw meat or a glycerine extract of it, I might be able to cure the disease. In a paper published in the *British Medical Journal* of Feb. 21, 1874, I mentioned the result of this treatment in some cases in which I tried it at St. Bartholomew's Hospital. In none of them was a cure effected, but in some of them there was temporary benefit. These cases were, I believe, the first in which portions of a solid organ were administered for the purpose of supplying a ferment which would alter tissue change. Before that time only ferments obtained from the digestive canal had been used in medicine.

Since then, the administration of portions of various organs, especially the thyroid, has come very much into vogue.

[1] Ludwig's *Arbeiten* für 1868. Dritter Jahrgang, p. 114. Leipzig, 1869.

Encouraged by the success which attends this method of treatment by thyroid or other glands, I have again been trying raw meat in diabetes. The results which I have obtained are much the same as before. I find distinct amelioration of the symptoms, but I cannot say that I have yet succeeded in curing a case. Of this method, it is interesting to note, that though our knowledge of ferments has increased considerably since Professor Kühne lectured on them in 1868-69, our knowledge of the ferments in muscles remains precisely as it was when I made experiments on them in 1873.

In Neumeister's *Lehrbuch der Physiologischen Chemie*, 2. Theil, p. 7, he says—"Endlich lässt sich aus den eingangs mitgetheilten, scheinbar spontanen Veränderungen des KÜHNE'schen Muskelplasmas die Gegenwart eines Milchsäure bildenden, sowie eines Myosinogen zersetzenden oder Myosin bildenden Enzyms annehmen. Aber der exacte Beweis für die Existenz dieser Fermente ist vorläufig noch zu liefern."

THE PATHOLOGY AND TREATMENT OF DIABETES MELLITUS.

(*British Medical Journal, January* 3, 1874.)

SECTION I.

There are two diseases to which the generic term diabetes has been applied. They are distinguished by the specific names diabetes insipidus and diabetes mellitus. They resemble one another in the copious secretion of urine, which is the characteristic symptom of diabetes insipidus, and is generally present, though not always, in diabetes mellitus. In the former disease, the urine contains no abnormal ingredient; while the latter is characterised by the presence of grape-sugar in it. The term hydruria is employed by some writers to designate the copious secretion of urine, and glycosuria the presence of sugar. A large increase in the quantity of urine often occurs, and sugar may be occasionally found in it, in health.[1] It is, therefore, well to restrict the use of the terms diabetes insipidus or diabetes mellitus to the permanent continuance of these symptoms. As the former disease is comparatively rare, the simple name diabetes is always applied in ordinary language to the latter; indeed, it is now sometimes used instead of glycosuria to signify the mere presence of sugar in the urine, although it may be but temporary.

Symptoms.—When patients suffering from diabetes come to a hospital, they usually complain that their mouth is dry, and they suffer from thirst. They pass a great quantity of urine, frequently having to rise during the night to micturate; and they have been losing flesh, although their appetite is undiminished or even greatly increased. Although these symptoms are generally present when patients apply for hospital relief, they are not, so far as my experience goes, the first indications of the disease. This fact was

[1] Brücke, *Sitzungs-Bericht der Wiener Akad.*, vol. xxix. 1859, p. 346.

much impressed upon me by a circumstance which occurred while I was a medical student. I chanced one day to see a working man who was under treatment for diabetes by a medical friend of mine. Being anxious to display my newly acquired knowledge, I said to the patient, "I suppose that the first thing you noticed was, that you made water very often, and were very thirsty." His reply took me somewhat aback. "Oh no!" said he; "the first thing I noticed was, that I could not do my day's work as I used to do." My attention was thus directed for the first time to muscular weakness as one of the earliest symptoms of diabetes; and I find that it has been the very first to appear in a large number of the cases recorded by Seegen in his elaborate work on this subject.[1] I have noticed it in several cases where no complaint was made of thirst, increased appetite, or frequent micturition. Another frequent symptom of diabetes is dryness of the skin, or the presence of an obstinate cutaneous eruption. I have not observed any characteristic form of eruption, nor any particular situation, as either the face or the body may be affected; but itching of the vulva in women is common, probably on account of the irritation caused by the saccharine urine. For my own guidance in practice, I have laid down the two following rules. Always examine the urine for sugar—(1) whenever a patient, especially a male, complains of weakness without any obvious cause; (2) whenever an obstinate cutaneous eruption is met with. In his *Handbook of Medicine*, Dr. F. T. Roberts gives the much more general and comprehensive rule to examine the urine in all cases of obstinate ill-health; and this is, no doubt, better than the rules which I have just mentioned; yet, by following these, I have several times detected diabetes when most of the ordinary symptoms were absent.

PATHOLOGY.—The presence of sugar in the urine as an abnormal constituent has been long known; but the pathological processes which it indicates are only now, thanks to the labours of Bernard, Cyon, Eckhard, Flint, Lusk, Pavy, and others, beginning to be clearly understood. Even yet we generally find diabetes ranged in text-books with albuminuria and other diseases of the kidneys, although we now know that these organs are not at all in fault, but merely separate from the blood the excess of sugar present in it. The blood always contains more or less sugar;[2] but, unless

[1] Seegen, *Der Diabetes Mellitus*, p. 109.

[2] Bernard, *Revue Scientifique*, 2nd ser., tome iv. p. 1023. (Several of these

it amount to more than about one-third per cent.,[1] it is not separated by the kidneys. Its appearance in the urine, therefore, indicates that an excessive quantity of it is present in the blood; and, if we can find out how this excess came to be there, we shall have discovered the pathology of diabetes. An analysis of blood from the crural or jugular veins, and from the femoral and carotid arteries, shows that less sugar is contained in the venous than in the arterial blood; and therefore destruction of sugar must go on somewhere in the organism.[2] Excess of sugar in the blood may thus be due to two causes—1, to increased introduction of sugar; or, 2, to diminished destruction of it; or, 3, to both of these together.

We will first consider the ways in which an excess of sugar may be introduced into the blood; and this involves the question, How does sugar come to be present in it at all? The ultimate source of the sugar and of every other constituent of the body is, of course, the food we eat; and this, as we may easily see in a typical meal of beef-steak, bread, and pudding, consists of fat, albumen, starch, and cane-sugar. The fat takes no part in the production of sugar within the organism, but the other three do. After they have entered the intestinal canal, the starch is converted into grape-sugar by the saliva and pancreatic juice, and the cane-sugar into a mixture of glucose and another sugar called lævulose [3] by

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lectures of Claude Bernard have lately been reproduced in the *London Medical Record*, and are well worthy of perusal, both for their matter and as admirable examples of method in experiment and clearness in diction.)

[1] Bernard, *Physiologie Expérimentale*, tome i. p. 302.

[2] *Revue Scientifique*, 2nd ser., tome iv. p. 1022.

[3] Sugars may be divided into two classes. Those of the first class are fermentable, yielding alcohol when acted on by yeast; and, when boiled with potash and sulphate of copper, give a deposit of oxide of copper. They have all the same formula, $C_6 H_{12} O_6$, but are distinguished from each other by their action on polarised light. The chief members of the group are glucose, or ordinary grape-sugar, and lævulose or lævoglucose. Glucose turns the plane of polarisation to the right, and thus is sometimes called dextrose or dextro-glucose, while lævoglucose turns it to the left, and hence its name. Glucose obtained from starch cannot be distinguished by chemical tests from that got from the liver; but it is quite possible that they are not the same, and that the one may be much more easily oxidised in the organism than the other. Indeed, Bernard states (*Physiologie Expérimentale*, tome i. p. 213) that sugar obtained from the liver is most easily destroyed in the body; next comes sugar from diabetic urine, then grape-sugar from starch, and, lastly, milk-sugar. The position of diabetic sugar between glucose from the liver and glucose from starch may be due to its being in many cases a mixture of the

the intestinal juice. The albumen is converted into peptone by the gastric and pancreatic juices. The sugar and peptones thus formed in the intestinal canal are absorbed by the intestinal veins, but they are not all at once poured into the general circulation and carried to the brain and muscles. If this were the case, these structures would get all their nutriment at once, and they would have to stow it away themselves for use during the intervals of fasting. Possibly the reserve-stores they would thus require to accumulate might clog their action; and, unless they could assimilate all the sugar at once, some of it would pass out in the urine, and thus be lost. It seems, at any rate, that such intermittent nutrition is not good for them, since a means of equalising it has been provided in the liver. This organ acts as a storehouse, in which the superfluous nutriment absorbed during digestion is laid up, and gradually given out again into the blood during fasting. The sugar which has been absorbed from the intestines is conveyed by the portal vein to the liver; and there it is converted into glycogen, and stored up in the hepatic cells. How the transformation is effected, we do not at present know; nor can we say whether the sugar is simply transformed into glycogen, or whether it splits up in some peculiar way so as to yield glycogen and fat. That glycogen is formed from sugar, and that sugar is stopped by the liver on its way from the intestine to the general circulation, is shown by several facts. In a starved animal, glycogen disappears entirely from the liver; but it quickly reappears if some sugar be injected into the stomach.[1] It is greatly diminished by fasting, and greatly increased by a full meal. When sugar is injected into the crural vein, it appears in large quantities in the urine; but when it is injected slowly into the

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two—part of it consisting of sugar formed from starch in the intestine, and not altered by the liver, and part of it derived from the transformation of glycogen.

The second class of sugars has for its chief members cane-sugar or saccharose, and milk-sugar or lactose. They do not undergo alcoholic fermentation with yeast, nor do they reduce copper like those of the first group; but they can be transformed into the sugars of the first kind by boiling with acids, or by the action of certain ferments, and then they are capable of fermentation and reduce copper. They both have the same formula, $C_{12}H_{22}O_{11}$. They both turn the plane of polarisation to the right, though cane-sugar does so more than milk-sugar. They are distinguished by their different solubility and sweetness.

[1] Tscherinow, *Wiener Acad. Sitzber. Math-Naturwiss.*, vol. li. Abth. 2.

portal vein, it is taken up by the liver, and not a trace of it is to be found in the urine. If the injection has been made too quickly, so that the liver cannot transform the sugar as rapidly as it is supplied, a portion of it passes into the general circulation and appears in the urine.[1] If the portal vein be ligatured, so that the blood finds its way from the intestines to the heart and body by means of the collateral circulation without passing through the liver, glycosuria occurs.[2] It would seem that it is only while sugar is being absorbed from the intestines that much of it is present in the portal blood, for generally there is less of it in the portal vein than of almost any other vessel in the body.[3] From the power of the liver to use up sugar in this way, Tscherinow has proposed to call its function glycophthiric, or sugar-destroying. Peptones also form glycogen, for the liver of a dog always yields a much greater quantity of this substance after the animal has had a meal of flesh than when it is fasting. Fick has advanced the hypothesis that the peptones which result from the digestion of albuminous food in the stomach are not again built up into albuminous substances in the organism, as is usually supposed. Instead of this, they undergo further decomposition, and split up into non-nitrogenous and nitrogenous bodies. The non-nitrogenous products are stored up in the body, and serve it as fuel; while the nitrogenous ones are excreted in the form of urea.[4] The urea is probably not formed directly from peptones; for, when they are injected into the blood, the urea is not increased till four or five hours after the injection; and, when meat is digested in the stomach, the increase of urea begins five or six hours after the meal.[5] It is probable, from Schultzen's researches,[6] that glycocine, leucine, and tyrosine are first formed, and that these afterwards become converted into urea. Fick does not say where he supposes

[1] Schöpffer, *Archiv für Exper. Pathologie und Pharmacologie*, vol. i. p. 71.

[2] Bernard, *Revue Scientifique*, 2nd sér., tome iv. p. 1066. Compare also the analysis (*Revue Scientif.*, tome iv. p. 1108), and *Observations* (p. 1023); also Schiff, *Untersuchungen über Zuckerbildung*, 1859, p. 3.

[3] Kühne, *Lehrbuch der Physiologischen Chemie*, p. 65. It is difficult to understand the conflicting statements of different observers on this point, except by supposing that their experiments were made on animals in different stages of digestion or fasting.

[4] Fick, Pflüger's *Archiv*, vol. iv. p. 40; also Rabuteau, *L'Union Médicale*, 1873, No. 107.

[5] Fick, *Verhandlungen der Physikal-Medicin. Gesellschaft zu Würzburg*, new series, vol. ii. p. 53.

[6] Schultzen and Nencki, *Zeitschrift für Biologie*, vol. v., iii. p. 124.

the decomposition of peptones to take place; but I think we are not far wrong in saying that it probably does so in the liver and muscles.

We may thus broadly say that albuminous food forms peptones in the stomach and intestines; and these are split up in the liver and muscles, so as to yield glycogen, a non-nitrogenous product, which is stored up in these organs, and urea which is excreted. This at once enables us to understand how it is that, in diabetic patients fed on animal food, the urea and sugar in the urine increase *pari passu;*[1] the sugar in them being in great part excreted with the urea, instead of being stored up as in the healthy body. The first great function of the liver, then, is to form glycogen from the sugar and peptones supplied to it from the intestines, and to store them up till wanted. This is termed by Bernard its glycogenetic function.[2] As the materials on which the liver acts are supplied to it by the *portal vein*, we may connect the *formation* of glycogen with this vessel; while, as I shall afterwards show, the *hepatic artery* is more closely related to its *destruction;* although, from the free anastomosis between them, neither vessel possesses either function exclusively. The portal vein in man has the power of contracting very considerably;[3] but the source of its vaso-motor nervous supply is not so well ascertained as that of the hepatic artery. We shall, however, return to this subject in another part of this paper.

We can at once see that, if the glycogenetic function be imperfectly performed, too much sugar will pass into the general circulation, and be excreted by the kidneys. It will only do this, however, during the time that the sugar produced by the digestion of starchy or saccharine food is being absorbed from the intestines; and the glycosuria arising from this cause will be intermittent, coming on after meals, and disappearing during fasting.[4] It is evident that, if the meals be taken so frequently that the whole of the sugar obtained from one cannot be excreted before absorption of the next one begins, the glycosuria will be remittent instead of intermittent. The sugar will be most abundant when digestion is

[1] Ringer, *Medico-Chirurgical Transactions*, vol. xliii. p. 323.

[2] *Revue Scientifique*, 2nd ser., tome iv. p. 1155.

[3] *Verhandlungen der Physikal-Medicin. Gesellschaft zu Würzburg*, 1854, p. 1.

[4] See Traube, Ueber die Gesetze der Zuckerausscheidung im Diabetes Mellitus, Virchow's *Archiv*, vol. iv. p. 118.

at its height, and scantier when it is nearly finished; but it will never be entirely absent. This kind of glycosuria will be completely arrested by abstinence from farinaceous or saccharine articles of diet. According to Pavy, it is not uncommon among elderly people; and, so long as the urine is kept nearly free from sugar by attention to diet, it does not appear to injure their health.[1] Even in health, the power of the liver to use up sugar is limited; and, if it be absorbed too quickly from the intestine, it will pass through the liver and appear in the urine. This occurs when sugar is taken in large quantities by men or by animals, unless it be prevented by some circumstance or other from being too rapidly absorbed.[2] Thus Bernard found that, when he injected a quantity of syrup into the stomach of a dog, sugar appeared in the urine. On repeating the experiment with a rabbit, no glycosuria was induced. The reason of this difference is, that the dog's stomach is generally empty, except immediately after a meal; and the syrup, quickly passed into the intestine, was altered by the intestinal juice, and was absorbed so rapidly that the liver could not convert it all into glycogen. The rabbit's stomach, on the contrary, always contains a large quantity of vegetable matter, even when the animal has been starved. This mass absorbs the syrup like a sponge, and only allows it to descend slowly into the intestine, so that digestion and absorption go on gradually, and the liver is able to convert all the sugar into glycogen.[3] Bernard shows in a very ingenious manner that the sugar which appears in the urine of the dog is really the same sugar which has been absorbed from the intestine and passed unchanged through the liver, and is not sugar derived from glycogen. The latter consists entirely of glucose; but that obtained from the urine of the dog contains both glucose and lævulose, which are the ordinary products of the digestion of cane-sugar by the intestinal juice.

The starch and canê-sugar contained in food are not usually converted into grape-sugar by the saliva, pancreatic and intestinal juices, so quickly as to supply sugar to the liver more rapidly than it can convert it into glycogen. An increase in the amount of any of these secretions, such as might be expected to occur in hypertrophy of the pancreas, for example, by leading to more rapid

[1] Pavy, *On Diabetes*, second edition, p. 144.

[2] Pavy, *op. cit.*, p. 141; and Vogel, in Virchow's *Handbuch speciellen Pathologie und Therapie*, vol. vi. Abth. 2, p. 49.

[3] *Revue Scientifique*, 2nd ser., tome iv. p. 1066.

conversion of the food into sugar, might cause diabetes, presenting similar characters to that produced by incomplete glycogenesis in the liver. Almost the only distinction between them would be that, digestion being completed more rapidly in the latter sort, the secretion of saccharine urine would begin sooner after meals and last for a shorter time than in the former. To ascertain this, an examination of the urine would require to be made very frequently; and I am not aware that any observations of this sort are on record. Several cases of glycosuria apparently depending on such alterations in the liver or digestion as have just been described, and arrested by abstinence from starch and sugar, have been recorded by Camplin,[1] Parkes, Traube,[2] Rayer, Bence Jones, and others. In some of these cases, the failure of the liver to perform its glycogenetic function seems to have been the sole cause of diabetes; in them, it could be warded off for many years by abstinence from farinaceous food. In others, the failure of this function seems to have been quickly followed by other changes; and then abstinence from starch failed to prevent the appearance of sugar in the urine, although it had done so at the commencement of the disease. It is possible that another imperfect kind of glycogenesis sometimes occurs when the liver forms glycogen rapidly enough, but of such a kind as to be too readily broken up again. The glycogen obtained from the livers of animals is by no means always of the same quality; for, according to Kühne, some specimens are converted by ferments into sugar with great rapidity, while others are only changed by them after the lapse of hours, although these very specimens may be at once changed into sugar by boiling them with acids.[3]

It is to be observed that the liver is not the only organ in the body which contains glycogen, although it is the chief one. The muscles also contain this substance;[4] and it is found in considerable quantities wherever cell-growth is actively going on, as, for example, in fœtal structures, or in the inflamed parts of the lungs in pneumonia. It is possible that it is first formed in the liver, and is merely carried to these other parts; but as it is readily

1 Camplin, *On Diabetes;* and *Medico-Chirurgical Trans.*, vol. xxxviii. p. 69; also other cases quoted by Parkes in his work on *Urine*, p. 317.

2 Traube, Virchow's *Archiv*, vol. iv.

3 Kühne, *Lehrbuch der Physiologischen Chemie*, p. 63.

4 Bernard, Kühne, and M'Donnell; Kühne's *Lehrbuch der Physiologischen Chemie*, p. 307; Nasse, Pflüger's *Archiv*, vol. ii. p. 97.

changed into sugar in the blood, it seems much more likely that muscles and young cells possess also, to some extent, glycogenesic powers, and that the glycogen they contain is actually formed by them from sugar, or peptones supplied to them by the blood. The sugar they receive may either be derived from glycogen in the liver, or directly from intestinal digestion, for it is almost certain that, although a great part of the sugar and peptones is stopped by the liver, the whole of them is not.

Diabetes, from imperfect glycogenesis, then, is to be ascribed chiefly to the liver; but the possible participation of the muscles is to be borne in mind.

SECTION II.

(*British Medical Journal, January* 10, 1874.)

THE second great function of the liver is to give out, during fasting, the nutriment which it has stored up during digestion. This is effected by the glycogen, which has been stored up in the organ, becoming gradually transformed into sugar again. It is then washed out of the liver by the blood and carried with it into the general circulation. The conversion of glycogen into sugar is effected by means of a diastatic ferment, of which a minute quantity only is present in the liver itself, but which is contained to a much larger amount in the blood. When the flow of blood through the liver is slow, the transformation of glycogen goes on gradually, but it is quickened whenever the current becomes more rapid. It seems probable that, although the blood of the portal vein may have something to do with the transformation of glycogen into sugar, this process is more closely connected with the circulation through the hepatic artery; for those lesions of the nervous system which increase the flow of blood through the liver and induce diabetes, have, according to Cyon,[1] little influence over the calibre of the vein, but cause the artery to dilate widely. As the blood from the artery flows into the portal vein, any increase in the circulation within it also quickens that in the vein to some extent. The circulation in the liver may be increased either by raising the pressure of blood in the arteries generally, so that the blood flows more quickly through the hepatic artery, although its size may remain the same as before, or by causing it to dilate, so that it receives a greater share of blood, while the pressure in the arteries generally remains the same.

[1] Cyon and Aladoff. Reprint from the *Mélanges Biologiques* (which Professor Cyon was kind enough to send to me); and *Bulletin de l'Académie Impériale de Pétersbourg*, vol. viii. p. 91.

The pressure of blood in the arteries generally may be raised by compressing any large artery, by violent muscular efforts, or by interference with respiration. The operation of these causes is followed by a greater production of sugar in the liver, its increase in the blood of the vena cava, and even its appearance in the urine. Schiff was able to produce diabetes by ligaturing large vessels, and Pavy[1] found in his experiments that whenever an animal struggled either on account of discomfort or because its respiration was interfered with, the quantity of sugar in the blood of the vena cava and carotids was at once increased. According to Michea and Reynoso,[2] it appears temporarily in the urine after an epileptic or convulsive hysterical fit. This power of muscular action to increase the proportion of sugar in the blood is exceedingly interesting, for sugar is destroyed in the muscles during their contraction, and is in all probability to be regarded as at least a part of the fuel from which they derive their energy.[3] The action of muscles, which causes the destruction of sugar within them, at the same time leads to an additional supply being furnished to them, and thus the balance of waste and supply is properly sustained. The occurrence of sugar in the urine of persons suffering from cholera, or who have died from exposure to cold, is probably also to be attributed, at least in part, to the contraction of the blood-vessels near the surface of the body increasing the circulation in the liver. The intermittent glycosuria which has been observed to be present during or after a fit of ague, and absent during the interval, may also be ascribed to the rise in the general blood-pressure which occurs during the paroxysm.

Dilatation of the hepatic vessels, and increased flow of blood through them, may be produced by paralysing their vaso-motor nerves either directly or reflexly. The vaso-motor centre (*a*) is situated in the medulla oblongata. From it proceed those constant stimuli to all the vessels in the body by which their state of moderate contraction, or tone, as it is often termed, is maintained. The vaso-motor nerves for the hepatic vessels, indicated in the figures by the dotted line which accompanies them, pass from the vaso-motor centre down the spinal cord for a certain distance, then proceed through some of the communicating branches to the

[1] Pavy, *On Diabetes*, pp. 62, 68, and 145.

[2] Trousseau, *Clinique Médicale*, ed. 2me, tome ii. p. 665.

[3] Ludwig and Genersich, *Arbeiten aus dem Physiologischen Anstalt zu Leipzig*, 1871, p. 75.

sympathetic cord and through the splanchnic nerves to the liver. The point at which they leave the spinal cord and pass to the sympathetic is not quite certain. According to Cyon and Aladoff[1] they leave the cord by means of the fibres (*c*), which accompany the vertebral artery, passing in them to the lower cervical ganglia. Thence they proceed in two fibres (*d*), one of which passes on either side of the subclavian artery, forming the annulus of Vieussens, to the first dorsal ganglion (*e*), and thence through the gangliated cord of the sympathetic (*f*), the splanchnics (*h*), to the cœliac ganglion (*i*), and along the hepatic vessels to the liver. (Fig. 1.)

By dividing these nerves at any point between the medulla and the liver, the influence of the vaso-motor centre will be removed, and the hepatic vessels will dilate. Unless other circumstances should interfere, the flow of blood through the liver will be accelerated, and the production of sugar increased. Diabetes arising from division of the nerves is generally supposed to be permanent. In this it differs from diabetes induced reflexly by irritation of nerves, which ceases shortly after the irritation has passed off. This distinction is applied to that produced by operations; for, of course, permanent diabetes may depend on permanent irritation, and this is probably frequently the case where the disease occurs in man. Schiff[2] found that diabetes could be produced by division of the anterior columns of the spinal cord between the medulla and the fourth cervical vertebra. This lasted for days or weeks, in fact, till the animal died. Cyon and Aladoff have also observed diabetes which they attributed to paralysis of the vaso-motor nerves of the liver, after section of the fibres which accompany the vertebral artery, of the last cervical or first dorsal ganglion, or of the fibres forming the annulus of Vieussens. Eckhard has not succeeded in confirming their results;[3] and it is, therefore, by no means improbable that the vaso-motor nerves of the liver do not always leave the spinal cord to join the sympathetic, by the fibres accompanying the vertebral artery, but sometimes pass further down the spinal cord, and leave it by the communicating branches going to some of the dorsal ganglia. (Fig. 2.) This is all the more probable, as we have an instance of a similar kind in the

[1] Cyon and Aladoff, *op. cit.*
[2] Schiff, *Untersuchungen ueber Zuckerbildung in der Leber*, 1859, p. 108.
[3] Eckhard, *Beiträge*, vol. vii. tome i. 1873, p. 19.

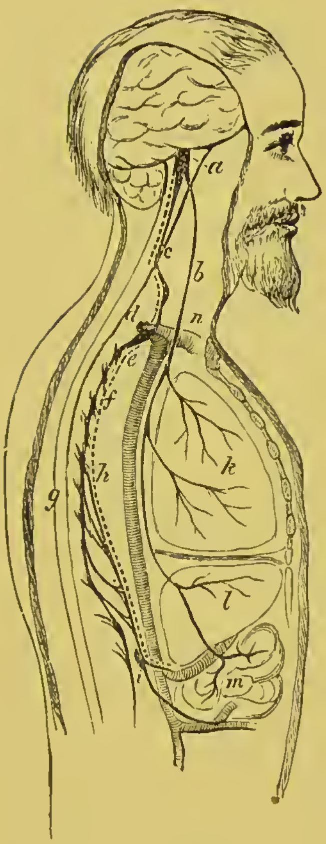


Fig. 1.

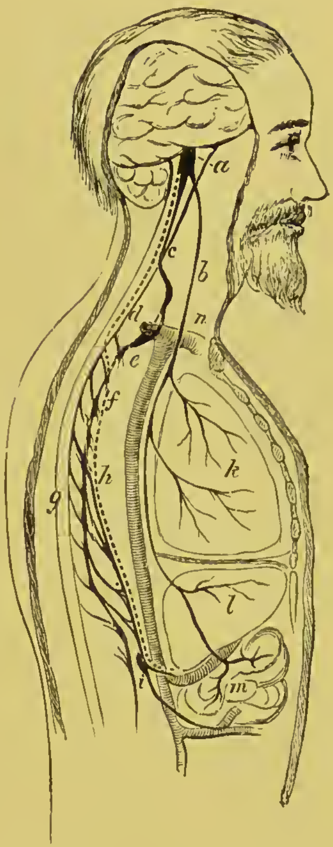


Fig. 2.

Fig. 1.—Diagram showing the course of the vaso-motor nerves of the liver, according to Cyon and Aladoff. These nerves are indicated by the dotted line which accompanies them : *a*, vaso-motor centre ; *b*, trunk of the vagus ; *c*, passage of the hepatic vaso-motor nerves from the cord along the vertebral artery ; *d*, fibres going on each side of the subclavian artery, and forming the annulus of Vieussens ; *e*, first dorsal ganglion ; *f*, gangliated cord of the sympathetic ; *g*, the spinal cord ; *h*, splanchnic nerves ; *i*, cœliac ganglion, from which vaso-motor fibres pass to the hepatic and intestinal vessels ; *k*, the lungs, to which fibres of the vagus are seen to be distributed ; *l*, the liver ; *m*, the intestine ; *n*, the arch of the aorta.

Fig. 2.—Diagram showing another course which the vaso-motor nerves of the liver may possibly take. The letters indicate the same parts as in fig. 1. The hepatic vaso-motor nerves are here represented as passing lower down the cord than in fig. 1, and leaving it by the communicating branches to the second dorsal ganglion. It is possible that they may sometimes leave by the branches to the first, and sometimes by those going to a lower ganglion. In such cases any irritation to the third or one of the other cervical ganglia may cause diabetes by being conveyed along the vertebral artery and up the cord as indicated by the dark line, to the vaso-motor centre, where it may cause reflex inhibition, in the same way as any irritation to the vagus.

case of the cardiac nerves.[1] As the vaso-motor nerves of the liver pass along the gangliated cord and the splanchnics, one would expect that section of these structures would produce diabetes. But this is not the case, for the sympathetic cord may be divided between the tenth and twelfth ribs, or the splanchnics may be cut, without sugar appearing in the urine. On the contrary, when other means, such as puncture of the fourth ventricle, have been employed to induce it, no sugar appears in the urine if these nerves have been previously cut. At first sight, this result is very perplexing; but Cyon has most ingeniously explained it, by reminding us that it is not mere dilation of the hepatic vessels, but increased circulation through them, which accelerates the formation of sugar; and the width of the vessels is of little consequence if there be not sufficient blood to fill them. Now, the vessels of the intestine, especially when the digestive canal is long as it is in rabbits, are so capacious, that when dilated they can hold as much blood as all the rest of the vascular system put together, and their vaso-motor nerves are also contained in the lower part of the cord and in the splanchnics. Consequently, when these are divided, the vaso-motor nerves of the intestinal vessels become paralysed as well as the hepatic ones, the vessels themselves dilate and retain so much blood that there is not enough left to increase the flow of blood through the liver, even though the hepatic vessels may be standing wide open to receive it. But if the vessels of the liver be first dilated, and the cord or splanchnics be then cut, the formation of sugar is not arrested; for, a brisk circulation having once become established in the liver, it still continues, although the intestinal vessels may become dilated.

A similar explanation may be given of the results obtained by Pavy, in one of his experiments.[2] He isolated the hepatic artery, portal vein, and hepatic duct, and then carefully divided all the remaining structures in the lesser omentum, including therefore the nerves passing to the liver. Notwithstanding that the hepatic nerves had been thus divided, and the splanchnics left uninjured, no sugar appeared in the urine. At first sight, this seems rather extraordinary, but a little reflection will show that the conditions are similar to those in Cyon's experiment. It is almost impossible to divide all the nerves of the liver without irritating the intestines

[1] Schmiedeberg, Ludwig's *Arbeiten*, vol. vi. p. 34.

[2] Pavy, *op. cit.*, p. 171.

and causing a considerable amount of congestion in them. Dilatation of the vessels produced in this way will have the same effect as division of the splanchnics. While watching a distinguished German physiologist dividing some of the nerves in the mesentery of a dog, I have seen the intestine become greatly congested, and so much blood has gone to it that there was not sufficient circulation in the brain to sustain its activity, and the dog, which was being operated on, slept soundly, although it had received no narcotic.

The second way in which the hepatic vessels may be dilated is by reflex paralysis or inhibition, as it is generally termed, of their vaso-motor nerves. Every one knows that, when a sensory nerve is irritated, the impression is transmitted to the vaso-motor centre, and arrests its usual action over the vessels of the part to which the sensory nerve is distributed. Thus, when a grain of sand falls into the eye, the irritation which it occasions to the sensory nerves of the conjunctiva is conveyed by them to the vaso-motor centre, and arrests the action of that part of it which regulates the contraction of the conjunctival vessels. In consequence of this, they become dilated and full of blood, and continue so while the irritation continues; but, so soon as it is removed, the vaso-motor centre again regains its wonted power, and the vessels return to their normal size. The same is the case with the liver; and its sensory nerve is the pneumogastric. If this nerve be cut across, and its lower end irritated, no effect on the liver can be noticed; but, if its upper end be stimulated, the vessels of the liver dilate, the circulation increases, and sugar appears in the urine.[1] Irritation of the roots of the pneumogastric, in Bernard's famous experiment of puncture of the fourth ventricle, has the same effect as stimulation of its trunk. This experiment is performed by pushing an instrument like a bradawl through the skull and cerebellum till it reaches the olivary fasciculi in the medulla oblongata. The instrument is prevented from injuring the anterior motor fibres of the medulla by a needle-like point which projects about the eighth of an inch from the middle of its edge. This is too fine to injure them itself, and, by coming in contact with the occipital bone, it prevents the edge of the awl from going too far. The irritation thus occasioned to the vagus roots inhibits the vaso-motor centre of the liver, and in half-an-hour or an hour, sugar appears in the urine. It does not remain more than a few hours, but disappears when the irritation

[1] Bernard, *Physiologie Expérimentale*, tome i. p. 326.

has passed off; and in this it differs much from the diabetes produced by dividing the vaso-motor nerves of the liver. When this is done by cutting the anterior columns of the cord in the neck, sugar, as has been already mentioned, will persist for days or weeks.[1]

Irritation of the peripheral terminations of some branches of the pneumogastrics has a similar effect to one applied to their roots or trunks. These nerves are distributed to the liver, lungs, heart, stomach, intestines, etc., but these filaments do not all seem to have the same power of inducing dilatation of the vessels. Diabetes can be produced by irritating the liver by needles[2] or electrodes[3] placed in it; and irritation in the intestine seems occasionally to have the same effect, for there is a case on record of diabetes caused by the presence of a tapeworm in the intestines, and immediately cured by its removal. The influence of the cardiac, gastric, and other branches has not been well ascertained. Eckhard has noticed the occurrence of diabetes after operations on the abdominal cavity without any definite lesion of nerves. The pulmonary branches seem to have a most important action, as the air inhaled during respiration appears to supply them with a constant stimulus, and thus continuously inhibits, to a certain extent, the vaso-motor nerves of the liver. When the pneumogastrics are cut across, this influence is, of course, removed, the hepatic vessels contract, and the production of sugar diminishes.

Increased respiration, on the other hand, seems to have the effect of increasing the formation of sugar; for Tieffenbach[4] observed that artificial respiration, performed by blowing air into the lungs by means of bellows, sometimes produced glycosuria. The appearance of sugar in the urine of animals poisoned by woorara is probably due partly to the artificial respiration employed to keep the animal alive, as well as to the action of the poison on the muscles, which will be considered afterwards. This is all the more probable because, when respiration is kept up to allow the animal to recover from the effects of woorara, sugar makes its appearance. The fact that it does not do so while the animal is com-

[1] Schiff, *Untersuchungen über Zuckerbildung in der Leber*, 1859, p. 108.

[2] Schiff, *op. cit.*, p. 106.

[3] Pavy, *op. cit.*, p. 137.

[4] Tieffenbach, Inaugural Dissertation; Königsberg, 1869. Abstracted in *Centralblatt für die Medicinischen Wissenschaften*, 1869, p. 179.

pletely paralysed, points to a reflex production of the phenomenon; for Schiff[1] has found that large doses of woorara paralyse the sensory as well as the motor nerves; and, as this loss of sensibility will destroy reflex inhibition, it is sufficient to explain the non-occurrence of reflex dilatation of the hepatic vessels while much woorara is present in the system. He states also that, when the respiration is effected gently, and the cannula is not tied into the trachea, but only laid loosely in it, so that the lungs are not over-distended by the force of the bellows, diabetes is not produced.[2] When the nerve-centres are very deeply narcotised, as when an animal is thoroughly under the influence of ether, even puncture of the fourth ventricle will not cause diabetes;[3] and Pavy[4] found no sugar in the urine of animals when he extirpated the superior cervical ganglion under the influence of chloroform, although it appeared when he narcotised the animals with the fumes of puff-ball, which, though it stupefied them, would probably not affect the vaso-motor centre through which the irritation of the operation would influence the hepatic nerves.

The glycosuria which is often observed after inhalation of carbonic oxide,[5] ether, and chloroform, may also be ascribed to irritation of the pulmonary branches of the vagus by these drugs before anæsthesia has become complete. If narcosis be quickly produced, sugar is not unfrequently absent; but it generally appears if narcosis be induced slowly, so that the irritant vapour acts long on the lungs, while the vaso-motor centre is yet unaffected by it. The glycosuria is not due to the struggles of the animal during the administration of the anæsthetic; for Schiff found it in a hedgehog which only succumbed to the influence of the anæsthetic after a long time, but did not make the slightest movement during the whole time.[6] The beneficial effect of opium and codeia in diabetes is probably due in part to their lessening reflex inhibition in the liver, as opium most assuredly does in the case of some other glands, and thus diminishing the production of sugar. It seems probable also that reflex inhibition may follow irritation of

[1] I am uncertain where this is published. Schiff himself informed me verbally several months ago of his discovery.

[2] Schiff, *Journal de l'Anatomie et de la Physiologie*, 1866.

[3] Schiff, *Untersuchungen über Zuckerbildung*, p. 10.

[4] Pavy, *On Diabetes*.

[5] Schiff, *Untersuchungen über Zuckerbildung*, p. 124.

[6] Senff, Inaugural Dissertation, Dorpat, 1869; Henle und Meissner's *Jahresbericht*, 1869, p. 173.

other parts of the encephalon, and possibly also of sympathetic ganglia, as well as of the roots, trunks, and branches of cerebro-spinal nerves.

The diabetes which has been observed after injuries of the cerebral lobes in man, of the cerebellum in animals by Eckhard,[1] of the superior cervical ganglion by Pavy, of the optic thalami, cerebral peduncles, pons Varolii, middle peduncles of the cerebellum, and of the cervical sympathetic cord and sciatic nerve by Schiff,[2] is probably due to this cause, as in all these cases it is only temporary, and not permanent. Irritation of the sciatic nerve in man seems to have the same effect as in animals, for temporary diabetes has been observed during an attack of sciatica.

There is another possible cause of increased formation of sugar in the liver; and that is, a greater proportion of diastatic ferment in it or in the blood which flows through it. The quantity of ferment in the livers of animals varies, and it is sometimes absent altogether. The same is probably the case with the blood. We do not know whether this ferment is peculiar to the blood, or whether it is ptyalin or pancreatic ferment absorbed from the intestines. Tiegel,[3] indeed, states that it differs from pancreatic ferment in being insoluble in glycerine; but Von Wittich has obtained a diastatic ferment from the liver by glycerine, and I have done the same. It is possible that there may be two ferments having a similar action. Pepsin seems to be absorbed from the stomach, for it has been found in the muscles and even in the urine by Brücke; and pancreatic ferment seems also to be absorbed, for Hüfner found a ferment, possessing like it the properties of converting starch into sugar and of digesting fibrine, in the salivary glands and lungs. The increased secretion of a hypertrophied pancreas, which Niemeyer asserts to be common in diabetes, may thus not only act by quickening the conversion of starch into sugar in the intestines, but by increasing the transformation of glycogen after its absorption into the blood. But atrophy of the pancreas is quite as common a lesion in diabetes as hypertrophy; and if we suppose, as is usually done, that the only function of the pancreas is that of forming ferment, it is difficult to explain the occurrence

[1] Eckhard, *Pester Medicin-Chirurgische Presse*, No. 7, 1873, p. 98; and Hulz, *Beiträge zur Hydrurie und Melliturie;* Marzburg, 1872.

[2] Schiff, *Journal de l'Anatomie et de la Physiologie*, 1866, p. 376; and *Untersuchungen über Zuckerbildung*, p. 214.

[3] Tiegel, Pflüger's *Archiv*, vol. vi. p. 249.

of diabetes under these conditions, except on the supposition that in both of them the nerves of the organ are irritated, and cause reflex dilatation of the vessels of the liver in the same way that irritation of the liver itself does. But if we suppose that the pancreas not only forms ferment, but also excretes ferment already circulating in the blood, in much the same way as the liver both forms and excretes bile, we at once see that the diastatic ferment which Hüfner supposes to be found in many parts of the body may accumulate in the blood because the pancreas can no longer excrete it, and thus lead to diabetes; for both bile and pancreatic juice can only be partially absorbed in the normal condition; another part will be evacuated with the fæces. I apprehend, however, that this explanation will seem to many persons to be too hypothetical, and that irritation of the pancreatic nerves and reflex dilatation of the hepatic vessels will appear a more probable cause of diabetes in cases of diseased pancreas. Plosz and Tiegel[1] have found that the ferment is contained in the blood-corpuscles alone, and not in the serum. When the blood-corpuscles are destroyed, the ferment acts vigorously,[2] as it is then set free. The diabetes observed by Harley after the injection of ether into the portal vein is probably due to the blood-corpuscles being dissolved by the ether.

I have already mentioned that the muscles contain glycogen, and, during their action, sugar is actually formed in them. The possibility of changes similar to those in the liver occurring in them must be borne in mind as a possible factor in diabetes.

[1] Pflüger's *Archiv*, 1873, vol. vii. p. 391.
[2] Tiegel, Pflüger's *Archiv*, vol. vi. p. 249.

SECTION III.

(*British Medical Journal, February* 21, 1874, p. 221.)

HAVING considered the effect of increased formation of sugar, we must now look at the diminished combustion of it as a cause of diabetes.

The healthy organism is able to consume not only all the sugar produced within itself, but even more; and, if a solution of glucose or glycogen be injected in small quantities under the skin or even into the veins of an animal, no sugar will appear in the urine.[1] This destruction of sugar probably goes on chiefly in the blood, lungs, and muscles, though it may take place in other tissues as well. Its occurrence in blood after it has been drawn is shown by the sugar contained in it disappearing after a short time when it is kept at a moderate temperature; and there is no reason to suppose that this does not go on within the body, more especially as Binz[2] and Zuntz have shown that the formation of acid, which goes hand in hand with the destruction of sugar, occurs even more quickly while the blood is still fluid, or, as we may say, alive, than after coagulation has taken place. The important part played by the lungs in the destructive process is evident from the great diminution which the sugar sometimes undergoes during its passage from the right side of the heart to the carotid artery; and the powers of muscle in this respect are shown by the observation of Ludwig and Genersich,[3] as well as of Bernard,[4] that the blood which passes through the vessels of a contracting muscle contains much less sugar when it issues from the vein than when it enters the artery. And yet, strangely enough, Ludwig and Scheremetjewski[5] found that, after grape-sugar had been injected into the

[1] Tieffenbach, *op. cit.*

[2] *Archiv für experimentelle Pathologie und Pharmacologie*, vol. i. p. 20.

[3] Ludwig's *Arbeiten*, 1871, p. 75.

[4] Bernard, *Revue Scientifique*, 2nd series, tome iv. p. 1022.

[5] Ludwig's *Arbeiten*, 1869, pp. 144 and 141.

veins of an animal, little or no increase took place in the oxygen consumed or the carbonic acid given off from the lungs—a result which indicates that grape-sugar, *as such*, is not burnt off in the body. On the other hand, however, they found that, when lactic acid as well as other organic acids, combined with soda, were injected into the veins, the amount both of oxygen and carbonic acid rose greatly, showing that these acids underwent combustion with great facility. Glycerine also undergoes combustion readily. Now, Bernard finds that, as the sugar disappears from blood, its place is taken by lactic acid;[1] and, as Du Bois-Reymond has shown, an accumulation of sarcolactic acid in muscles occurs after they have been kept in action.[2] Muscles after death acquire an acid reaction by the formation within them of lactic acid from sugar or glycogen which they contain;[3] and, when added to a solution of grape-sugar, they will cause the formation of acid in it also. That this conversion of sugar into lactic acid is due to a ferment, is shown by the close correspondence between it and other processes of fermentation.[4] Thus, if the blood be heated so as to destroy the ferment, the sugar will remain unchanged;[5] and Binz and his scholars have shown that quinine and other substances, which lessen fermentation, likewise diminish the production of acid in blood. Bernard has also demonstrated that blood, like other ferments, acts more rapidly on glucose than levulose; whereas alkalies, to which the destruction of the sugar in the blood was long attributed, act more rapidly on the latter kind of sugar than on the former.

The interesting experiments of Schultzen show more clearly than any others how sugar is decomposed in the body. A year or two ago, he found that, in animals poisoned by phosphorus, the processes of oxidation are arrested in the organism, but those of decomposition by ferments go on.[6] In such animals, urea disappears from the urine, and is replaced by leucine and tyrosine, which, in the healthy organism, are converted into urea.[7] No

[1] Bernard, *Revue Scientifique*, 2nd series, tome iv. p. 1159.

[2] Du Bois-Reymond, *Journal für Chemie*, 1859, vol. lxxvii. p. 233.

[3] Bernard, *op. cit.*, p. 1159.

[4] Some time ago I tried to separate this ferment from muscles by Von Wittich's method, by glycerine, but was only partially successful.

[5] Bernard, *Leçons au Collège de France*, tome i. p. 230.

[6] Schultzen und Riess, *Ueber acute Phosphorvergiftung*, Separatabdruck aus den *Annalen der Charité*, Band x.

[7] Schultzen und Nencki, *Zeitschrift für Biologie*, vol. viii. p. 124.

sugar appears in the urine, but a kind of lactic acid is found in quantities exactly proportional to the amount of sugar afforded to the animals by their food. This kind of lactic acid agrees exactly in its properties with the aldehyde of glycerine, and Schultzen considers the two bodies to be identical.[1] He thinks that, in the normal condition, sugar is split up by the action of a ferment into this glycerin-aldehyde and glycerine in the manner indicated in the following formula: Glucose $C^6H^{12}O^6$ + Hydrogen H^2 = Glycerin-aldehyde $C^3H^6O^3$ + Glycerine $C^3H^8O^3$. When the ferment is absent, as he supposes it to be in some cases of diabetes, the sugar is not split up, and so does not undergo combustion, but is excreted in the urine. In diabetics, the processes of oxidation are not impeded; for the nitrogenous waste products appear in the urine as urea, and not as leucine, as they do when oxidation is impaired in phosphorus-poisoning. The imperfect combustion of the sugar is due, he considers, to the want of ferment which should prepare it for oxidation, and not to the want of oxygen.

In view of these facts, we are, I think, justified in believing that the sugar which is present in the blood becomes converted by the aid of a ferment in the blood, muscles, and probably lungs also, into lactic acid and glycerine; and then undergoes combustion, thus sustaining the temperature of the body. Supposing, however, that this ferment is deficient, a greater or less proportion of the sugar will not undergo conversion into acid, and will then remain unconsumed, as in Ludwig and Scheremetjewski's experiment.[2] Unless the combustion of that quantity of sugar which does undergo transformation with the aid of fat, etc., be sufficient to sustain the temperature of the body, it will fall more or less below the normal; and this is actually what we find in a considerable number of diabetic patients. The muscular weakness which is observed in them is just what we would expect from the muscles being unable to make full use of the sugar which ought to supply them with energy for their work, though it is not improbable that excess of sugar in the blood may itself cause muscular fatigue. Whether this be the true explanation of their weakness or not, it is difficult to say; for we do not yet know how it is that chemical action is transformed in muscle into mechanical work; nor are we acquainted with the manner in which oxygen is stored up during the hours of rest, in order to be expended during the time devoted

[1] Schultzen, *Berliner Klinische Wochenschrift*, 1872, No. 35, p. 417.

[2] Ludwig and Scheremetjewski, *op. cit.*, p. 145; Schultzen, *op. cit.*

to labour. Whenever we do learn this, we shall gain a deeper insight into diabetes; for Pettenkofer and Voit have found that patients afflicted with this disease have not the power which a healthy man possesses, of absorbing more oxygen during the night than they need at the time, and using it up during the day. They are thus obliged to work as it were from hand to mouth, and are incapable of any great exertion.

The formation of lactic acid depends on the sugar as well as the ferment, and it is quite possible that the former may be in fault as well as the latter. I have already mentioned that different specimens of glycogen are acted upon by ferments with varying degrees of facility; and it would seem to be the same with sugar even when derived from similar sources, for Bernard, when arranging the different sorts according to the ease with which they are destroyed in the body, ranks sugar obtained from the liver above diabetic sugar.[1]

The destruction of sugar probably goes on in the blood, brain, glands, etc., as well as in the muscles, but to a much less extent. In order that the sugar in the blood may be destroyed in the muscles, however, it must pass into them. Now, very little blood circulates through muscles when they are at rest, but the flow is much increased when they become active. More sugar will thus be carried to them and destroyed; but, as I have already mentioned, muscular exertion raises the blood-pressure, and increases the circulation in the liver and the formation of sugar in it, so that the balance is maintained. We can readily see that, if the liver go on producing sugar, and it be not destroyed in the muscles, it will accumulate in the blood, and at last appear in the urine. This, I believe, takes place in animals paralysed by woorara. Bernard thinks that the glycosuria produced by this poison, and also by large doses of morphia, is not due to their action on the muscles, but is to be ascribed entirely to their causing paralysis of the hepatic vaso-motor nerves and increased formation of sugar in the liver. I believe that woorara does exert this action; but the glycosuria is not due to it alone, but to its effects on the muscles also. My belief is founded on the experiments of Dock;[2] and, to make the grounds of it more intelligible, I shall shortly give the

[1] It is possible that this may be due to the sugar from diabetic urine consisting sometimes of a mixture of sugar derived from the liver. and sugar absorbed from the intestine.

[2] Dock, Pflüger's *Archiv*, vol. v. p. 571.

results of his research. 1. When rabbits are starved, glycogen disappears from the liver. 2. In such rabbits, puncture of the fourth ventricle does not produce diabetes. 3. After a few injections of cane-sugar into the stomach of starved rabbits, glycogen appears in the liver. Injections of water, albumen, or fat, have not this effect. 4. If the fourth ventricle be punctured before the injection, no glycogen appears in the liver, and no sugar is found in the urine. 5. Poisoning by woorara produces diabetes in starved rabbits, although puncture of the fourth ventricle does not. 6. After poisoning by woorara, injections of sugar into the stomach do not produce glycogen in the liver; but sugar is abundantly found in the urine.

I must also mention that Weiss[1] has discovered that a considerable amount of glycogen remains in the muscles of starved animals after it has completely disappeared from the liver; and they retain their muscular activity as long as it is present in the muscles. The explanation of these results is by no means difficult. Indeed, it would have been easy for any believer in Bernard's theory of the causation of diabetes by puncture of the fourth ventricle, to foretell that it would not induce glycosuria in animals when their livers contained no glycogen; for, this being absent, no increase in the hepatic circulation could increase the formation of sugar. When the puncture is made, and the hepatic vessels are consequently dilated before cane-sugar is injected into the stomach, no glycogen is found in the liver; for it is converted into sugar, and washed away by the blood as soon as it is formed. It does not appear in the urine, for it is used up by the muscles as quickly as it is absorbed from the intestines. When the animals are poisoned by woorara, there is no accumulation of glycogen in the liver, for the poison paralyses the hepatic vessels, and thus produces the same effect as puncture; but it also prevents the muscles from using up the sugar, which therefore appears in the urine.

The occurrence of sugar in the urine of starved animals after woorara-poisoning must be due to the glycogen in the muscles undergoing conversion into sugar, and its transformation being arrested at this stage, instead of changing into lactic acid and glycerine, and undergoing combustion as it ought to do.

There are some other substances, such as nitrite of amyl[2] and

[1] Weiss, *Sitzungsberichte der Wiener Academie*, vol. lxiv. p. 284.

[2] Gamgee and Rutherford, quoted by Brunton in Sanderson's *Handbook for the Physiological Laboratory*, p. 515; and Hoffman, Reichert und Du Bois-Reymond's *Archiv*, 1872, p. 746.

nitro-benzol,[1] which probably cause diabetes chiefly by arresting the decomposition of sugar, although they may also act on the liver.

Since sugar has to be converted into lactic acid before it is burned off, and it is not improbable that the amount of this conversion is more or less regulated by the demand, we would not unnaturally expect that the injection of easily combustible organic acids into the blood, by preventing the combustion of sugar, might lead to its accumulation in the blood and its appearance in the urine. And such, in fact, is the case. According to Eckhard,[2] sugar appears in the urine of a rabbit after the introduction into its veins of carbonate, acetate, succinate, or valerianate of soda; and G. Goltz[3] noticed it after putting lactic acid into the stomach of the same animal.

To recapitulate shortly what has already been said: The liver has two functions—1, that of taking up the sugar which it receives from the intestines, and converting it into glycogen; and 2, that of forming sugar again from glycogen. The muscles probably possess three functions. 1. They take up sugar from the blood and convert it into glycogen. 2. They form sugar again from this glycogen. 3. They change both the sugar they form and the greatest part of that which they receive from the blood into lactic acid and glycerine, which undergo combustion. Diabetes may arise—1, *from increased formation of sugar*, due to (*a*) excessively rapid digestion of starch or sugar; (*b*) to failure or imperfection in the glycogenetic function of the liver, and possibly to some extent also of the muscles; (*c*) to increased transformation of glycogen into sugar, due to accelerated circulation through the liver, or a larger proportion of ferment in the organ or the blood. The circulation may be quickened either by increase of the general arterial pressure or by dilatation of the vessels of the liver, and especially of the hepatic artery. Increased blood-pressure may be due to muscular exertion, such as occurs in epilepsy, or to contraction of the arterioles, such as is caused by impeded respiration, exposure to cold, cholera, and Bright's disease. The hepatic vessels may be dilated reflexly by irritation applied to the vagus, either at its ends in the lungs, liver, or intestine, in its trunk, or at its roots in the medulla, or to the cerebrum, cerebellum, pons, and probably some

[1] Ewald, *Centralblatt der Medicinischen Wissenschaften*, 1873, p. 819.
[2] Eckhard and Kulz, *Pester medico-chirurgische Presse*, Feb. 1873, p. 113.
[3] G. Goltz, *Centralblatt für die Medicinischen Wissenschaften*, 1867, p. 705.

of the sympathetic ganglia. They may also be dilated, and the current in them accelerated, by section of their vaso-motor nerves at any point between the medulla and the liver, provided that the intestinal vaso-motor nerves are not also divided, and the supply of blood so much diminished that no increase in the hepatic circulation follows the section. Increased formation may also occur in the muscles. 2. Diabetes may also arise *from lessened combustion*, due either (*a*) to insufficiency of the ferment which should convert the sugar into lactic acid and glycerine, (*b*) to an altered quality of the sugar which enables it to resist the action of the ferment, or (*c*) to diminished circulation through the muscles preventing the sugar from coming sufficiently into contact with the ferment.

DIAGNOSIS.—We now come to the somewhat difficult task of trying to distinguish between the cases of diabetes depending on these different causes; and this, I am afraid, I can very imperfectly perform. I have already mentioned that too rapid digestion of starch and imperfect glycogenesis in the liver would both give rise to glycosuria, occurring after meals, and arrested by abstinence from starch and sugar; but diminished combustion might lead to a somewhat similar result. In the latter case, however, the temperature would probably be below the normal, and in the former would not. The appearance of the patients, too, as Harley[1] points out, is very different. When the diabetes depends on diminished combustion, they are weak and emaciated, while in diabetes from increased formation of sugar, they are often ruddy and plump. Diabetes depending on increased transformation of glycogen in the liver will go on, even though an exclusively flesh-diet be employed, and may thus be distinguished from diabetes depending on imperfect glycogenesis. If it be due to increased transformation alone, and there be not at the same time diminished destruction of sugar, the temperature will not be below the normal. A temperature below the normal may be regarded as indicating that combustion of sugar is imperfect; and it by no means signifies that the disease is due to this cause alone,[2] for at the same time there may be other conditions present which cause increased formation of sugar. Supposing that, the temperature being normal, we find that sugar continues to appear in the urine although the patient has been restricted to a diet of flesh alone,

[1] George Harley, *The Urine and its Derangements*, p. 240.

[2] Rosenstein, Virchow's *Archiv*, xiii. 1858; and Harley, *op. cit.*, second edition, p. 265.

and we have thus determined that the diabetes is due to increased transformation in the liver, the next question is, On what does this depend? Is it due to increased blood-pressure, or to dilatation of the hepatic vessels? A general rise in the blood-pressure may be readily detected by the combined use of the stethoscope and sphygmograph. The tracing taken by the latter instrument will show an oblique rise and slow descent of every pulse-wave. Such a tracing indicates high pressure, if the cardiac sounds be at the same time loud. A similar form may be obtained when the heart is feeble, although the blood-pressure is not above the normal; but the cardiac sounds will then be feeble also. If there be no rise in the general blood-pressure, we may suspect dilatation of the hepatic vessels; but it will be difficult to discover the cause of it. We must bear clearly in mind the various afferent and efferent nerves, irritation or paralysis of which may cause glycosuria, and localise the lesion as best we can by other symptoms which may point to one part or another. Thus, if we find glycosuria coming on in a phthisical patient, we may suspect irritation of the pulmonary branches of the vagus by the tubercle to be the exciting cause; while intestinal irritation, or impaired mental or motor functions, will direct our attention to the abdominal branches of the vagus, or to the cerebrum and cerebellum. A history of ague will induce us to consider whether the source of irritation may not be in the nerves of the liver or spleen. One would expect that certain aneurisms of the subclavian artery, by stretching and paralysing the fibres forming the annulus of Vieussens, would cause glycosuria; but I am not aware of any cases of this sort.

TREATMENT.—The indications for treatment in diabetes are, 1, to lessen the production of sugar; and 2, in cases where its combustion is imperfect, to aid its transformation, and to supply easily combustible materials, so as to sustain the temperature of the body and impart muscular strength.

The reason for lessening the production of sugar is that, when an excess of it is present in the blood, it causes dryness of the mouth, thirst, and discomfort, symptoms which disappear when its quantity is reduced. In order to effect this, all articles of food containing starch or sugar should be excluded from the patient's diet. Thus, no sugar at all will be formed in the intestine, any glycosuria depending on imperfect glycogenesis will disappear, and the treatment will also constitute a means of diagnosis. At the same time less glycogen will be formed in the liver, for a diet of

meat does not afford nearly so much material for it as one containing starch or sugar. Thus glycosuria, depending on increased transformation of glycogen in the liver, will also be diminished.

The patient must be supplied with a diet consisting of nitrogenous food, such as butcher-meat, fish, eggs, and soups. Fat (which does not contribute in the least to the formation of sugar) may be given in all its forms, such as cream, butter, cheese, and oil. Spinach, lettuce, and cresses may be freely used, but celery and radishes only sparingly; while potatoes, carrots, parsnips, turnips, peas, French beans, cabbage, Brussels sprouts, cauliflower, brocoli, asparagus, sea-kale, and fruit of all kinds, both fresh and preserved, should be avoided, with the exception of nuts and almonds. Instead of bread, the patient should take either the gluten-bread supplied by Bonthron, 106, Regent Street, and Van Abbot, 5, Princes Street, Cavendish Square, or the bran- or almond-biscuit prepared by Blatchley, 362, Oxford Street.[1] Dr. W. Richardson strongly recommends[2] that the change from an ordinary to a restricted diet should be made very gradually, lest the patient become disgusted with his food. Rather than produce this injurious effect, it is better to relax the diet and permit him to eat sparingly of bread made of whole meal, or even of white bread toasted and potatoes. In the case of diabetes which depends on imperfect glycogenesis, the restricted diet will be sufficient to prevent the appearance of sugar in the urine. Should it still continue notwithstanding the adoption of this regimen, the circulation in the liver must be reduced as much as possible. For this purpose, the blood-pressure should be reduced, and the blood should be drawn to the surface of the body by warm clothing and warm baths. The Turkish bath should be used occasionally. Bleeding is not likely to be employed now as a means of lowering the blood-pressure, but Lefèvre records a case in which diabetes was cured by its use conjointly with that of warm baths.[3]

It is very difficult to determine the point at which the irritation is situated on which reflex dilatation of the hepatic vessels may depend, and even if we could localise it, we might be unable to remove it. We therefore direct our attention rather to the nervous centres, through which the irritation is reflected to the liver; and,

[1] An excellent diet-table from which this has been taken is contained in Pavy's work on *Diabetes*, 2nd edition, p. 263.

[2] Richardson, *On Diabetes*, p. 80.

[3] Lefèvre, Magendie's *Journal*, 1824, p. 363.

by lessening their excitability, we diminish its power over the hepatic vessels. The two remedies which are most serviceable for this purpose are opium and its alkaloid, codeia. Bromide of potassium and atropia, which might be expected to be useful, have been found of no service by Kretschy and Duchek.[1] Half a grain of opium may be given three times a day to begin with, and the dose gradually increased.[2] Codeia, an excellent remedy, which we owe to Dr. Pavy, may be given in doses of a quarter to half a grain three times a day at first. My friend Dr. Image, of Bury St. Edmunds, informs me that in one case he began with half a grain three times a day, and increased the dose by half a grain every four days, till the patient was taking five grains three times a day. The sugar then disappeared from the urine, but the treatment was continued for some time longer. About a year after, mental anxiety again brought on the disease, and five grains of codeia were at once given twice a day. This did not prevent the appearance of sugar in the urine, but it disappeared on the administration of five grains three times a day.

Excellent results have been obtained by Kratschmer from the use of morphia, the sugar disappearing completely from the urine, and the nutrition of the patient being greatly improved.[3] Harley recommends conia or cannabis Indica, and has seen great benefit derived from a combination of conium, cannabis, and hydrocyanic acid.[4]

[1] Kretschy, *Wiener Med. Wochenschr.*, 1873, Nos. 3 and 4.

[2] I am not aware that the effect of opium in lessening the reflex dilatation of the hepatic vessels, which otherwise would occur when the central end of the vagus is stimulated, has ever been shown by direct experiment. Bernard has demonstrated the power of anæsthetics, such as chloroform, to lessen reflex dilatation of the vessels of the salivary glands (*Revue des Cours Scientifiques*, 1869, vi. p. 383). Without being aware of his observations, I discovered, two years ago, that opium did so likewise. I was engaged in demonstrating to a class the functions of the various nerves connected with the submaxillary gland. The dog on which I was operating was deeply narcotised with opium; and, having exposed the nerves in presence of the class, I explained to them that, when I irritated the gustatory nerve by a galvanic current, the stimulus would be conveyed to the nerve-centre and cause reflex dilatation of the vessels of the gland, and a flow of saliva from its ducts. I then applied the irritation, but, to my surprise and disgust, not the slightest effect was produced. No change took place in the vessels, nor did the slightest trace of saliva issue from the duct. The opium had completely paralysed the nerve-centre, through which the effect was to be produced, and rendered the irritation fruitless.

[3] Kratschmer, *Wien. Acad.*, *Sitzungsbericht*, 1872.

[4] George Harley, *On the Urine*, 2nd edition, pp. 280 and 261.

In certain cases, quinine proves extremely serviceable; and, whenever there is a history of exposure to malaria, it ought to be tried. Blumenthal[1] narrates a case of diabetes occurring in a man frequently troubled with migraine, and of a very nervous temperament. The sugar was slightly lessened by a meat diet and the use of Carlsbad water, but the benefit was but slight, and the disease resisted codeia, arsenic, lactic acid, tannin, iron, and glycerine. Under the use of eleven and a half to thirty grains of quinine daily, the quantity of urine diminished; its specific gravity decreased; the thirst became less troublesome; the albumen, which had previously occasionally appeared in small quantities, entirely disappeared; and the nervous affections rapidly improved.

Several years ago, Saikowsky[2] discovered that the livers of animals poisoned by arsenic contain no glycogen, and that it is impossible to produce diabetes in such animals either by puncture of the fourth ventricle or by curare. He therefore proposed arsenic as a remedy in diabetes. From this recommendation, Leube[3] gave it to the extent of one-third of a grain daily with good effect.

Devergie and Foville, junior,[4] have also employed it with advantage. They were induced to do so by observing the diminution in the quantity of sugar which it produced in a case where it was administered for prurigo occurring in a diabetic patient. They begin with one drop of Fowler's solution twice a day, and gradually rise to twelve or fifteen drops, occasionally diminishing the dose, or stopping it altogether, as the symptoms seem to require.

Alkalies were proposed as a remedy for diabetes by Mialhe[5] nearly thirty years ago, on the supposition that they would accelerate the decomposition and combustion of sugar in the organism. They frequently do prove very beneficial, but it is not certain that they increase the combustion of sugar. It is quite possible that they do so; but, at any rate, the experiments of Lomikowsky[6] seem to show that they lessen the production of sugar by diminishing the quantity, or preventing the action, of

[1] Blumenthal, *Berliner Klin. Wochenschrift*, 1873, No. 13.
[2] Saikowsky, *Centralblatt für die Medicin. Wissensch.*, 1865, p. 769.
[3] Leube, *Deutsch. Archiv für Klinische Medicin*, 1869, vol. v. p. 372.
[4] *Gazette Médicale de Paris*, 1870, No. 22.
[5] Mialhe, *Annales de Chemie*, 1844, sér. iii., tome xii. p. 120.
[6] Lomikowsky, *Berliner Klin. Wochensch.*, Oct. 6th, 1873, p. 475.

the diastatic ferment by which glycogen is transformed into sugar. This author finds that, when bicarbonate of soda is given to dogs for some time, little or no sugar is found in their livers, even when they have lain for several hours after death. They contain glycogen, and therefore the absence of sugar must be due to want of ferment. Livers taken from other healthy dogs, which had got no alkalies, always contained much sugar when allowed to lie in the same way. Lomikowsky's conclusion is confirmed by the experiment of Pavy,[1] who found that the previous injection of carbonate of soda into the circulation prevented the appearance of sugar in the urine after removal of the superior cervical ganglion. A convenient way of giving alkalies is in the form of Vichy and Carlsbad waters. These seem to be more beneficial when the patient visits the springs than when he drinks them at home, probably because he is thus induced to take exercise, the use of which we shall presently see. The Vichy waters are purely alkaline, but the Carlsbad waters are purgative also, and are therefore to be preferred when any tendency to constipation exists. When the destruction of sugar is defective, we may endeavour both to increase it, and to supply easily combustible materials to the body in place of those products of the decomposition of sugar which normally serve as fuel to the organism.

Several months ago, I attempted to increase the decomposition of sugar in diabetics by supplying the ferment which I supposed to be wanting. Since sugar is probably decomposed chiefly in the muscles, the ferment which splits it up is probably contained to a much greater extent in them than in any other part of the body. By giving the patients raw meat, we may hope that the ferment contained in it will be absorbed from the intestine into the blood, and there act on the sugar. It is necessary that the meat be given raw, for the heat to which meat is exposed in cooking completely destroys all ferments. The patients on whom I tried this plan of treatment were under the care of Drs. Black, Andrew, and Duckworth; and I take this opportunity of expressing my thanks to these gentlemen for the readiness with which they afforded me the means of making observations, and their kindness in supplying me with every facility, as well as to Messrs. Russell and Sawtell for the assistance they rendered me. The meat was finely chopped up in a sausage-machine, mixed with pepper and salt, and was either spread upon bread and butter, German fashion,

[1] Pavy, *On Diabetes*, 2nd edition, p. 176.

or was made into a paste with bread and milk. Shortly after I began the treatment of one case, I learned from Dr. Duckworth that it had been tried empirically with complete success by the captain of a merchant vessel, who had prescribed for himself. In the cases treated in the hospital, however, no cure was effected, although in certain of them there was some temporary benefit. In order to increase the oxidation, iron may be administered; and I find a combination of perchloride of iron with hydrochlorate of morphia and spirit of chloroform very satisfactory.

As a great part of the sugar is probably broken up in the muscles by the action of a ferment, it is in the highest degree desirable that it should be brought as much as possible into contact with them. For this purpose, the circulation of the blood in which the sugar is contained must be increased as much as possible through the muscles, by making the patient take active exercise despite the languor of which he complains. Dr. William Richardson,[1] who himself suffered from diabetes, says, in his excellent work on this disease: "Ten years ago, when I was first seized with an acute attack of diabetes, which threatened soon to end fatally, I became so weak, and had so little muscular power, that I could not walk a hundred yards without great fatigue. The muscles of my legs were so powerless, that I fell two or three times; and, in going down the slightest slope, I had to pay unusual attention to my legs, or I was sure to fall. I began to take exercise regularly two or three times a day; wet or fine, I took it. Gradually, I gained strength, so as to be able to walk five or six miles a day without fatigue. I now regularly walk from three to five or six miles a day." He also gives the case of a gentleman who derived but little benefit from a meat diet, Vichy water, iodide of potassium, or liquor arsenicalis, till he exchanged his sedentary life for active exercise, when his symptoms rapidly improved, and he soon recovered perfect health. The advice which Dr. Richardson gives regarding exercise seems to me to be so good, that I take the liberty of quoting it. "The exercise should be regularly sustained day by day, even in wet weather it should not be intermitted; of course, great care should be taken against wet feet, and the shoes or boots ought to be changed in wet weather on returning home; it should never be carried to real fatigue; a feeling that exercise has been taken is the most that should be felt. To carry into effect regular and sustained daily exercise requires great moral

[1] Richardson, *On Diabetes*, p. 91.

courage and energy, the languor and feeling of weakness are so great; but, if the exercise be only carried out patiently and perseveringly, the task will become not only more and more easy, but soon no longer a task, but positively a pleasure."

Easily combustible material may be supplied to the body in the shape of lactic acid, glycerine, cod-liver oil, cream, etc. As has already been shown, the two former are likely to be of little use in cases of diabetes depending on increased transformation alone, and not on diminished combustion; glycerine being even hurtful, and lactic acid able to induce the disease in animals.

Lactic acid may be administered in doses of from fifteen minims to a drachm; but, instead of giving it alone, I should prefer to give it in the form of lactate of soda, as a double benefit would be thus obtained. The organic acid, as we have already seen, is burnt off when combined with soda, and the salt is converted in the blood into a carbonate; and in this way we get the benefit which is often obtained by an alkaline treatment. The form in which I always recommend it, however, is that of buttermilk, as this quenches the thirst, supplies food, and also contains a ferment which, if absorbed, may be useful in aiding the conversion of sugar into lactic acid within the body. I am inclined to attribute the benefits occasionally derived from the use of skimmed milk to its possessing similar properties to buttermilk; but I consider the latter superior. When it is allowed to become very sour, and all its milk-sugar has been converted into lactic acid before it is used, it would probably be still better. I first heard of the use of sour buttermilk from an old woman in the country many years ago. She was loud in her praises of its efficacy in wasting diseases, and had striking cases to narrate by way of illustration. The manner of employing it which she recommended was to put the buttermilk into a large vessel, and add a fresh quantity every few days to replace what was drunk. The vessel was not to be washed out, so that a little of the old and sour milk always remained and quickened the formation of acid in each new addition. I have never used it in this way; but, if I were living in the country, I should certainly give this plan a trial. I find that in London it is exceedingly difficult to obtain buttermilk at all.

Glycerine is strongly recommended by Schultzen[1] as a substance which readily undergoes combustion in the body. He finds that, when a patient is placed on meat diet, the sugar disappears from

[1] Schultzen, *Berliner Klinisch. Wochenschrift*, 1872, No. 35.

the urine, and the thirst is no longer felt; but the nutrition remains indifferent. When glycerine is given at the same time, the muscular weakness diminishes, and the patient rapidly improves. He gives about half a fluid-ounce to a fluid-ounce and a quarter by measure (20 to 50 *grammes* by weight) of glycerine, with about 80 grains (5 *grammes*) of tartaric or citric acid in rather less than four pints of water daily. The patient drinks it from time to time instead of plain water. If the quantity of glycerine be increased to about an ounce and a half (60 *grammes*), there are sometimes nausea and diarrhœa. If the patient be not very thirsty, the glycerine may be given in one-half or one-quarter the quantity of water. If Schultzen's theory of the decomposition of sugar be correct, a combination of glycerine, or lactic acid, or some butter-milk, along with a meat diet ought to yield very satisfactory results. Pavy found that glycerine increased the quantity of sugar passed by a patient, and made him thirsty. He gave it in doses of ten ounces a day, and the unsatisfactory result he obtained is probably due to the quantity being so large; for the glycerine, being more easily combustible than the sugar, appears to have prevented its decomposition, and thus allowed it to accumulate in the blood. This case of Pavy's indicates to us that, where diabetes depends on formation of sugar being increased without its combustion being diminished, we need not expect to benefit our patients by supplying them with easily combustible foods, such as lactic acid and glycerine. We need, therefore, hardly try these remedies, except when the temperature of the body is low, as ascertained by the thermometer, or by the feelings of the patients, who complain of cold, and like to be constantly near the fire or covered with warm clothing.

CLINICAL LECTURE ON DIABETES.

Delivered at St. Bartholomew's Hospital on Friday, November 15, 1895.

GENTLEMEN,—It is said that if a man loses himself in a snow-storm, or in the primeval forest, he goes wandering round until he finds himself at the point from which he started. We find very much the same thing in the life of a man, and probably it is this tendency that has led me to choose the subject of "Diabetes" for my first clinical lecture here as full physician of the hospital, as it was the subject that I first took up when I began clinical work in this hospital a great many years ago. The results of my first work were published in the *British Medical Journal* of January and February 1874, and I have had these papers reprinted so that each of you may have a copy and consult them, because I have dealt with the subject a good deal more fully there than I could do in the short time at my disposal now.

We find the same kind of tendency not only in individual men, but in numbers of men; and we notice that fashions in dress and in manners come round again and again after the lapse of a number of years. We find the same thing in ideas. The wise man has said, "There is no new thing under the sun. Is there any thing whereof it may be said, See, this is new? it hath been of old time, which was before us."[1]

Now the newest thing in medicine is the administration of tissues and organs in a raw state, either by the stomach or by subcutaneous injection. In place of the raw tissues themselves, extracts of those tissues are frequently employed. This method of treatment is, to a great extent, a new one, and is effecting to a considerable extent a revolution in medicine; yet it is not a new plan. From time immemorial savages have been accustomed to eat parts of the bodies of their slain enemies, especially when those enemies were distinguished by special bravery, or to eat the

[1] Ecclesiastes i. 9, 10.

hearts of the lions or other beasts of prey which they might have overcome, with the idea that by consuming the hearts or other parts of the bodies, either of their enemies or of beasts of prey, they would acquire the bravery and power which distinguished their foes.

The plan of treatment by the administration of raw organs was tried by me in this hospital just about twenty-two years ago in cases of diabetes. It seemed to me that some cases of diabetes were due to imperfect utilisation of sugar in the muscles, and that therefore the proper method of treatment would be to supply a substance contained in the muscles which would enable the patient again to utilise the sugar which was present in his blood. This substance I believed to be a ferment which would have the power of splitting up the sugar into the more easily combustible form of lactic acid. I accordingly administered raw meat. I got a certain amount of benefit in some of the cases, but I obtained no very definite cure. Not finding that I was able to give raw meat in sufficient quantity to gain the effect I desired, I made an attempt to extract from the raw meat a ferment by the method which was then usually employed, viz. solution in glycerine. I noticed, however, that this also was insufficient to effect my purpose, and accordingly the treatment was given up. The method of using organs or extracts of organs has again been revived in recent years on account of the success that has attended the administration either of thyroid gland or of its glycerine extract in cases of myxœdema. Attention has also been much directed to the subject lately by the researches of Brown-Séquard, who has found that extract of testicles seems to have a tonic effect upon the body generally. In consequence of the results obtained by the use of extract of testicles and of thyroid glands, researches have been made upon the effect of various other glandular organs. For example, parts of kidney, extract of kidney, extract of suprarenal capsules, extract of brain, and so on, have been given in such cases as seemed appropriate. The results have, however, been rather disappointing, and in none of the other diseases have we obtained any such definite and successful results as in the case of myxœdema.

I may here give a few short extracts from the third of these papers (*British Medical Journal*, February 21, 1874).

"In view of these facts, we are, I think, justified in believing

that the sugar which is present in the blood becomes converted by the aid of a ferment in the blood, muscles, and probably lungs also, into lactic acid and glycerine; and then undergoes combustion, thus sustaining the temperature of the body. Supposing, however, that this ferment is insufficient, a greater or less proportion of the sugar will not undergo conversion into acid, and will then remain unconsumed, as in Ludwig and Scheremetjewski's experiment."

"Some time ago I tried to separate this ferment from muscles by Von Wittich's method, by glycerine, but was only partially successful."

"Several months ago I attempted to increase the decomposition of sugar in diabetics by supplying the ferment which I supposed to be wanting. Since sugar is probably decomposed chiefly in the muscles, the ferment which splits it up is probably contained to a much greater extent in them than in any other part of the body. By giving the patients raw meat, we may hope that the ferment contained in it will be absorbed from the intestine into the blood, and there act on the sugar. It is necessary that the meat be given raw, for the heat to which meat is exposed in cooking completely destroys all ferments. The patients on whom I tried this plan of treatment were under the care of Drs. Black, Andrew, and Duckworth; and I take this opportunity of expressing my thanks to these gentlemen for the readiness with which they afforded me the means of making observations, and their kindness in supplying me with every facility, as well as to Messrs. Russell and Sawtell for the assistance they rendered me. The meat was finely chopped up in a sausage-machine, mixed with pepper and salt, and was either spread upon bread and butter, German fashion, or was made into a paste with bread and milk. Shortly after I began the treatment of one case, I learned from Dr. Duckworth that it had been tried empirically with complete success by the captain of a merchant vessel, who had prescribed for himself. In the cases treated in the hospital, however, no cure was effected, although in certain of them there was some temporary benefit."

It is sad in one way, but satisfactory in another, to find that the attempts I made so long ago have not even yet been surpassed; that the researches that have been made upon the treatment of glycosuria by the administration of various organs have hitherto not been successful, any more than the attempts I made by the administration of raw meat. In my attempt to extract ferment

from the muscles I was not successful; but I find that even now physiologists have been no more successful, and in a book on physiological chemistry, which is probably the best and most recent work on the subject, I find the following passage:—"Endlich lässt sich—die Gegenwart eines Milchsäure bildenden Enzyms annehmen. Aber der exakte Beweis für die Existenz dieser Fermente ist vorläufig noch zu liefern" (Neumeister, *Lehrbuch der physiologischen Chemie*, 2ter Theil, p. 7; Jena, Gustav Fischer, 1895). So that although one is obliged to assume the presence of the ferment, which I believe to be present in muscle, physiologists even now are not able to prove the absolute existence of this ferment any more than I could.

Now, at the time when I wrote those papers upon the pathology and treatment of diabetes, attention was chiefly directed to the nervous system as the origin of the disease, because every one's mind was filled with the striking results of Claude Bernard's experiments on glycosuria consequent upon puncture of the fourth ventricle of the brain. During the time that has elapsed since these papers were published but very little work has been done in relation to the effects of nervous lesions upon glycosuria, but a good deal has recently been done in relation to the effect of other organs upon the liver and upon glycogenesis. Not only have the experiments of Brown-Séquard, Horsley, Murray, and others upon the testicles and thyroid gland led to the introduction of the system of administering extracts of organs, but they have also drawn attention to a very important function of organs, viz. internal secretion. The first example of internal secretion which we know to have been regularly recognised by physiologists was the internal secretion of the liver. Until Claude Bernard's time people looked upon the excretion of biliary matters as the chief function of the liver, and when they began to investigate the use of the bile, and found that it had very little or no action in digestion, they began to say that the liver was a fraud. This huge organ was the biggest gland in the body; yet all that it could do was simply to excrete a little bile, which was not much good for any purpose whatever. It had perhaps, a slightly laxative influence upon the bowel, but was not really half so good as a little aloes. So that practically here was the biggest gland in the body, placed in the most prominent position, and yet apparently useless. But when Claude Bernard took up the function of the liver, and showed that its real

use was not for secreting bile, but that it could act as a regulator of tissue change, people began to alter their ideas regarding the value of the organ. He showed that the liver was really what we may term the coal-bunker of the body; it gathered up within itself the soluble products of intestinal digestion, it stored them in itself during the periods of fasting, and gave them out gradually to the tissues as they were wanted.

Now this function of the liver is one of the very greatest importance, as you can readily see, because the soluble products of digestion are more or less injurious when poured into the blood in large quantities. It was thought at one time that the peptones coming from the breaking up of albuminous food were transformed in the liver. We now know that this transformation chiefly occurs in the walls of the intestine; that peptones formed by the splitting up of albuminous food during digestion are built up again into some form of albumin in the intestinal walls, but they probably reach the liver in such a condition that they are there also to a great extent stored up and partially split up. Peptones will yield a certain amount of glycogen, and an animal that is fed exclusively upon meat will, after a large meal of meat, be found to have stored up a good deal of glycogen in its liver. But the chief function of the liver is to act rather upon the products of the digestion of carbo-hydrates. As you know, starch is transformed in the intestine into sugar, which is soluble and easily absorbed; but this sugar if poured into the blood in too great a quantity would be excreted by the kidneys. It is therefore converted in the liver itself into insoluble glycogen, stays there in this form for a certain length of time, and is afterwards gradually changed back again into sugar and poured gently and gradually into the blood, according to the requirements of the various tissues to which the sugar serves as nutriment. Now we find that usually the organs of a man are able to do a good deal more than is required of them. We have two kidneys, although one would suffice, as we know from the way in which people get on after excision of a kidney. We have two lungs, but we know that people get along fairly well with one lung, and only a remnant of another. We have only one heart, and we cannot do without it: but the organs which are single, although their presence may be necessary, are rarely worked up to their full extent; and the heart, although its presence is absolutely indispensable to life, is rarely acting to its full extent, and the same

thing is the case with the liver. As a rule, the liver is capable of dealing with a great deal more sugar than is sent into it from the intestine; so that if any one of us were to take a very full meal of starch, or even if we were to consume a great deal of cane-sugar, we would probably find very little sugar in the urine, because our livers would be capable of dealing with it. There is, however, a limit to the powers of all organs—of the heart, of the lungs, and of the liver. And if you pour in too much soluble sugar into the stomach and intestines, either of a healthy animal or healthy man, you will be almost sure to find a certain amount of sugar present in the urine, because you have overstepped the limits within which the liver can deal with the sugar. You find the same thing in relation to albumen. Most of us can take a raw egg without any disadvantage, because we are able to digest it, and none of the egg-albumen finds its way through the kidneys. Some years ago Mr. D'Arcy Power and I made a number of experiments on our powers of assimilation.[1] We wanted to get artificial albuminuria in healthy men. I managed to swallow six eggs one after the other. The first was not at all bad,—in fact, rather nice; the second was doubtful, the third I did not care about, and you can hardly fancy how abominable the sixth seemed to be; but Mr. D'Arcy Power managed to swallow twelve. I found that my appetite prevented my taking more than six, and my internal organs were capable of dealing with six eggs, so that I got no albumin in my urine. Mr. D'Arcy Power, having been able to take twelve, overstepped the powers of his intestine and liver, and he got albumin in his urine. You may find that what holds true with egg-albumin holds true also with other forms of albumin; and although I was quite unable to take enough egg-albumin to get it to appear in my urine, I managed to get albumoses appearing in my urine by swallowing a large quantity of beef-tea made from meat extract. My intestine and liver were incapable of dealing with this soluble albumin just as Power's were with white of egg, and so it appeared in the urine. Now the limits of the powers, even of healthy men, vary very considerably in regard to sugar and to albumin, but there are certain cases in which they seem to be lessened. Diminution of the power of dealing with the sugar which is poured into the blood from the intestine tends to produce a form of glycosuria by

[1] Lauder Brunton and D'Arcy Power, *St. Bartholomew's Hospital Reports*, vol. xiii. p. 283. [Page 373.]

increasing the amount of sugar in the blood. For if the amount of sugar in the blood exceeds about one-third per cent.—that is to say, ·3 per cent.—it passes out into the urine, and gives rise to glycosuria. This imperfect synthetic action of the liver in converting the soluble sugar which is poured into the blood into insoluble glycogen, seems to be the cause of one form of glycosuria.

I would like to point out that just as we formerly included all cases of albuminuria under one general term, "Bright's disease," so we are apt now to include all forms of glycosuria under one general head, that of "diabetes." But you know perfectly well that there are very different forms of albuminuria, some of which are of comparatively little importance, others of which are deadly diseases. And there are very different forms indeed of glycosuria. Some forms are comparatively unimportant, others lead to rapid emaciation and speedy death. You will find that generally glycosuria or diabetes has been divided into two classes according to its causes.

1. Cases of increased formation.
2. Cases of lessened assimilation.

But I think we might divide the glycosuria first of all into two distinct classes. This division has been made already by Harley, who separated cases of glycosuria into the fat and the lean. The fat, however, may again be subdivided into two distinct classes. I would be inclined to limit the term glycosuria to the fat cases, diabetes to the lean ones. Lancereaux has mentioned that amongst the fat cases you will find glycosuria occurring early in life, about twenty-one in women and twenty-five in men, and the patients suffering from it are often excessively stout. I dare say that in coming up Ludgate Hill you have looked at the picture of Daniel Lambert. Now one does not know—at least, I do not know,—but I have very little doubt that Daniel Lambert had glycosuria. You very rarely come across a man so stout as that who has not got sugar in his urine. Now diabetes is generally looked upon as a wasting disease, but Daniel Lambert and men like him have not wasted; and one begins to think what would they have been like if they had not had some sort of safety-valve like glycosuria to get rid of the excess of carbo-hydrates they took. So that in these cases we may call the disease glycosuria, and not diabetes.

These cases of fat people having sugar in their urine at an early

age sometimes go on for a considerable length of time. As a rule, they run on for many years, and not unfrequently they may go on past middle age, and occasionally you may find them going on even to old age. There is another class of the fat kind of diabetes, which I think is perhaps even more markedly to be reckoned as glycosuria, and not diabetes. This class comprehends people about middle age, about forty-five years of age. Sometimes they may be stout; they generally are well nourished, and in them we find the symptoms associated with symptoms of gout, and more especially with discharge of uric acid. We have not had in the wards a typical specimen of the fat kind, but we have had two specimens of what I think was not diabetes, but gouty glycosuria. There was one man especially, a gardener, who was not staying in the wards, but came up occasionally, from Swanley. He was a tall man, well built, about fifty years of age, and when I first saw him in the out-patient room he had a large quantity of sugar in his urine. He had begun specially to notice that he was weak, and then he became very thirsty. He had a very greatly increased appetite, and yet he became weaker notwithstanding his increased appetite, and the increased amount of food he was able to digest. In him we had no external sign of diabetes at all. He remained well nourished and rather red in colour. In him we found that treatment was very successful, the only treatment that was necessary being to diminish the quantity of carbo-hydrates that he took. We simply cut him off starch and sugar, and in a very short time the urine became perfectly normal, and I hear it remains perfectly normal, no sugar being present in it whatever. There was another man in the wards who was also a specimen of this sort, only he was a good deal younger, and we had hoped to be able to try in his case some of the newer plans of treatment; but our hopes were frustrated, because when the carbo-hydrates were cut off he at once got well, and no more sugar was to be found. There was one point, however, to which I would like to draw your attention in his case, and that is that after the sugar disappeared from the urine it had still a high specific gravity. We were not able to ascertain the exact cause of this high specific gravity, but it reminded me of a case that I examined many years ago, in which after the sugar had gone from the urine inosite was found. It may be that inosite was present in this man, but we do not know because we were not able to get the chemical

analysis made, but I would draw your attention to the possible occurrence of inosite in cases where you get a high specific gravity, but where you do not get any increased amount of sugar.

We have, then, in these cases two fairly typical specimens of what we may term "gouty glycosuria" rapidly recovering. In another case we had a different result. A man was admitted with a large quantity of sugar in his urine, with a sore upon his back, and the physical signs of pneumonia in his lungs. Owing to his weak condition a very careful examination of the abdomen was not made. After a short time—in fact, one day after his admission—the sugar disappeared from the urine. In the two former cases the disappearance of the sugar from the urine was a good sign, and they got well forthwith. In this case, where the man was so severely ill, we did not look upon the disappearance of the sugar as a good sign, but, on the contrary, as a sign of probable approaching death, and this turned out to be right, because in two or three days more he died, and we then had an opportunity of making a post-mortem. Both lungs were found to be affected with phthisis, more especially the right; there was a large sore upon his back, sloughing, and having the characters more of a large sloughing carbuncle than an ordinary bedsore. The liver was decidedly cirrhotic. The pancreas was looked at with especial care, because pancreatic changes have recently come to be recognised as very important factors in the production of cases of obstinate diabetes. It seemed a little firm, but there was nothing very definite found to be the matter with it. Sections of it will, however, be made, and we will pay special attention to the microscopic structure of it, and see whether any alteration can be found. To the naked eye, however, the pancreas appeared to be normal. In this man we had what really seemed to be gouty glycosuria in its beginning running on to a very unfavourable result. Instead of clearing up, as the other two had done, he became worse and died, and yet there did not seem to be anything in the disease itself that was going to carry him off. But wherever you get glycosuria you are always more or less liable to certain complications. The presence of sugar in the tissues seems to cause them to become a more favourable nidus for the presence and growth of various organisms. You know that in cultivating any microbes the addition of a little sugar to the medium frequently makes it a much more favourable soil for the cultivation, so that microbes which would not grow

upon peptone broth alone may grow readily on the addition of a little sugar. Now something like this appears to occur in the body, and patients who have got glycosuria are liable first of all to boils and carbuncles, so that the appearance of boils and carbuncles very often leads you to examine the urine and see whether any sugar is present. It would appear that the microbes make their way through the sweat-glands or through the sebaceous follicles into the skin and subcutaneous tissue, and there they grow and multiply, giving rise to boils or carbuncles. You can readily see that what happens in the case of the skin will happen also in other organs,—for example, the lungs. In healthy people if the tubercle bacilli are inhaled, they take such a time to grow that they are expectorated by a healthy man before they are able to get a footing; but if they are inhaled by a man suffering from glycosuria they may find a better nidus, grow more quickly, and lead to phthisis. Probably this was what occurred in the patient that we had in the hospital. Therefore in cases of glycosuria you are always afraid of any infective diseases, whatever they may be, and one is afraid of performing operations on persons suffering from glycosuria because, as it is said, the wounds are apt to go wrong. Consequently it is an advantage to your patients and lessens their risks to have the sugar removed from the blood and from the urine as quickly as possible, even though the presence of the sugar may not appear to do the patient much harm.

In most of these cases all that is necessary is to prohibit sugar absolutely, and to lessen the starch in the food. A great deal of discussion has arisen as to whether it is advisable to prohibit starch entirely, or to give it in limited quantities. In my opinion it is not advisable to remove carbo-hydrates entirely from the diet. If you do this you find that the patients, as a rule, suffer very much, and that they practically get such an intense craving for carbo-hydrates that they will have them in spite of your prohibition; whereas, if you allow them in a limited form, you may get your patients to stick to the diet as you restrict it, and it is much better that they should take the diet which you have laid down than take the diet which they have laid down for themselves. Generally, you will find that the ordinary diet table for diabetics is this: proteids of all kinds, fish, flesh, fowl, and eggs are allowed in all forms, whether they be fresh or salted or potted, the only prohibition being that the meats or fish should not be

taken with sauces containing flour, starch, or sugar. All green vegetables should be allowed. Frequently such things as Brussels sprouts are prohibited, but if you forbid vegetables of any kind you lessen your patient's dietary very much, and, as a rule, I am inclined to allow fish, flesh, fowl, eggs, all green vegetables,—and, in fact, vegetables of any kind with one or two exceptions. These exceptions practically are carrots, beet, and potatoes. Carrots and beet contain a good deal of sugar, and potatoes contain so much starch that it practically comes to be almost the same as if the patients were taking sugar. But even potatoes may, I think, be sometimes allowed if they are given in one particular way. Diabetics, as a rule, complain very bitterly of their diet, and say that it becomes so distasteful to them. "If you could only give them a little bit of potato they would be so happy." You may allow a little potato if it is given in the form of the potato chips. A single potato cooked in this form may be made to fill almost a whole dish. It must be cooked, however, in one particular way, and this is the way. I think it is known to all the cooks on the Continent, but is not known to all the cooks in this country,—indeed, to very few. You must have a large deep pan, not a frying-pan, but a pan six inches deep, and this should be nearly full of oil or grease; dripping is as good as any other kind of fat. You put this on the fire, and it comes as you think to the boil, but this boiling is quite delusive. You let it go on boiling, and all the water that is mixed with the dripping boils away, and finally in place of the apparently boiling liquid you get a liquid with a perfectly smooth still surface, which is not boiling at all, and then is the time you are able to cook your potatoes. They should be cut in very thin shavings indeed, and should be then thrown into this practically boiling fat. When I say boiling I mean this very hot fat which does not appear to boil. They are then quickly taken out, and under the influence of the great heat they become firm and crisp upon the surface, and the fluid that they contain is boiled within these crisp surfaces by the heat, so that they are blown out, and each little shaving of potato, which was originally about as thick as a bit of cardboard, is now about three-quarters of an inch thick. These potato chips may be used in cases of diabetes, and you will find that the patients are very fond of them as a rule, and they are enabled to get down a quantity of food that they could not otherwise take.

Of the two classes that we have just been describing, we have seen one class at least and one sub-class, the so-called "fat" class, and the sub-class "gouty" glycosuria. There is another class which we have not had any opportunity of seeing yet, and that is the thin patients—the true diabetics. These thin patients become rapidly ill; they quickly lose their strength, they become much emaciated, and generally get a very great thirst. Their cases appear to be entirely different from those of gouty glycosuria, because they run a much more rapid course. Gouty glycosuria runs a very slow course, so much so that I have seen one case, a lady who was over eighty, who had been suffering from gouty glycosuria for over thirty years. She was a well-nourished old lady, and she suffered apparently no discomfort whatever from the disease; and really I was asked to see her not so much because there was anything the matter with her, but because the old lady insisted that she was suffering from a serious disease which lessened her strength, and her strength must be kept up by stimulants, of which she took rather more than her friends thought good for her. She lived on for some years after I saw her, and, I think, died at eighty-eight, although the glycosuria had lasted for thirty or forty years. So that when a patient comes to you with sugar in his urine, you must not at once tell him that he has got diabetes, because diabetes in the minds of your patients means that they have got a mortal disease, and that they are going to die in a few years. True diabetes is a mortal and rapidly fatal disease, killing them off in about three to six years; but gouty glycosuria cannot be called a mortal disease, because if an old lady dies at eighty-eight you can hardly say it was that which carried her off. Moreover in these cases of gouty glycosuria you will find it is not the glycosuria that is the cause of death except where it leads to complications, as in the case we had in the wards where it led to inflammation of the lungs with tubercle, or where it may lead to any other infective disease, from the readiness with which those germs grow in the tissues containing sugar.

It is well, then, when you get a case of gouty glycosuria to tell your patients that they are suffering from gouty glycosuria and not true diabetes. You should draw a sharp distinction between gouty glycosuria and true diabetes. It is possible that glycosuria may pass into true diabetes, but very often it does not do so, and there is time to warn your patient when the danger really threatens.

In cases of true diabetes we find that we are obliged to be even more strict in regard to diet than we are in the case of those who are suffering from gouty glycosuria. For in them, although the diet is strictly laid down and strictly adhered to, sugar will continue to appear in the urine, and one must do one's best to try and get it utilised.

The remedies that have been used in cases of diabetes are exceedingly numerous, and yet out of the whole of them there appear to be very few which are of any real service. Practically I think we may say that there is only one which is of very great utility, and that is opium and its alkaloids. The alkaloids are codeine and morphine. Codeine is, perhaps, rather more successful than morphine in one respect, viz. that you can push it further without giving your patient so much constipation, or without giving rise to that excessive drowsiness which morphine causes. But morphine has more power than codeine to stop the sugar. It is not only capable of stopping the sugar when administered in smaller doses, but it will also tend to stop the sugar after you have reached the limit where codeine seems to have lost its effect. It has seemed to me as a rule that patients are able to stand more morphine, or more codeine, when they are suffering from diabetes than when they are suffering from most other diseases, or than ordinary healthy people can stand. In one case I saw codeine pushed up to the dose of 15 grains daily—a large dose,—and this large dose was sufficient to stop the sugar; smaller doses were insufficient.

I have mentioned to you the chief remedy, but there are some other remedies which may be useful, and one of these is salicylate of soda, which I believe to be useful not so much in cases of true diabetes as in cases of gouty glycosuria, and the use of it is rather as a general remedy for gout than as a special one for sugar. I ought to mention here, perhaps, one caution in regard to the diagnosis of diabetes, or rather, I should say, of gouty glycosuria. An old clinical clerk of mine went into practice in the country a number of years ago, and after he had been in practice for about two years he came back to me and said that he was dying. He thought he had got diabetes. He had put himself on a rigid meat diet, and the more rigid it was the worse he became. I examined the urine, by boiling it with some Fehling's solution, and sure enough I got down at once a copious precipitate of yellow

oxide of copper. I tested it, however, with a bit of litmus paper, and found it to be intensely acid. I then mixed it with its own volume of liquor potassæ and heated it, but instead of getting a dark brown coloration as I should have done had there been much sugar in the urine, I got no coloration at all. Clearly, then, we had to deal here with a reducing body, but not with grape-sugar. I put a single drop of the urine under the microscope, and it simply crystallised into an almost solid mass of uric acid. The reducing body in the urine was simply an enormous excess of uric acid, and this caused so much reduction of the copper that my pupil believed that he was suffering from diabetes, and, of course, the more meat he ate the more uric acid he got. I told him to put himself on a vegetable diet, and he very soon became well, and has remained so for at least fifteen years. We must, therefore, be cautious in dealing with cases of gouty glycosuria, and not fall into the mistake of confounding them with cases of true diabetes.

There seems to be a loss of power to utilise sugar in all cases of glycosuria, both in those who are stout and those who are thin, and one of the things that we desire most to bring about is the utilisation of sugar in the organisation.

Now although I was unable years ago to cure cases of diabetes either by giving raw meat or glycerine extract of raw meat, yet it has been abundantly shown that sugar appears to be used up in the muscles; and therefore, if we want to get it utilised, we must get the sugar to circulate freely through the muscles. Dr. Richardson suffered from diabetes himself, and he expressed very strongly the view that exercise is of the utmost utility in glycosuria. He said that at first when you begin to take exercise you will find that it is very tiring, and that you wish to lie quiet; but if you go on in spite of your languor you will find that the languor will pass off, and after a while you will be able to walk with considerable freedom, and to take pleasure in the exercise, and at the same time feel very much better for it. But in all cases there is a difficulty about taking active exercise. In the case of remarkably fat people, they cannot take exercise because their bodies are too heavy. You will sometimes see this at Marienbad or at Carlsbad, whither a lot of those very patients travel in the luggage van because they are absolutely unable to get into any of the carriages. I saw one at Marienbad towards the end of the season who was able to walk about, but when he arrived at Marienbad he was in a very bad case,

because there was not a single vehicle at the station that would take him for fear of breaking the springs, and he had to get some sort of heavy cart to convey him to his hotel, and then he had a special one built, in which he was carried about. In cases like this it is absolutely impossible for our patients to walk. In the case of very thin, nervous patients, they are unable to walk because the exhaustion is so great. So that in all cases what we wish to do is to bring the blood freely into contact with the muscles, to allow it to circulate freely through them, and this we are able to do by the plan which has been advocated so largely by Weir Mitchell, viz. by massage. It was found by Ludwig and some of his scholars that if you stimulate a muscle you increase the blood-flow through that muscle. It seemed to me likely that the same result would be got from massage, so Dr. Tunnicliffe and I made some experiments, and we found that after the massage of a muscle the blood rushes through it three times as quickly as before. It may not seem very much to you to hear that the blood travels through the muscle three times as quickly as before, but when you see the blood travelling along two inches only in a glass tube in one minute before massage, and six inches in the same time after massage, it then strikes you as a very remarkable increase. In consequence of this effect on the circulation, in cases where patients are unfit to take exercise, either because they are too fat, or because they are too weak, you may substitute massage in bed for the exercise. There are many other points I should like to bring before you about this disease, but the time is nearly up, and I would only reiterate those things that I want you especially to notice.

I want you first of all to notice that there are really two distinct diseases in which you find sugar in the urine. There is glycosuria, generally gouty; and there is true diabetes. Glycosuria is associated with a well-nourished body, sometimes with a tendency to great deposit of fat; it runs a slow course; it may not kill the patient at all, although it does render him more liable to death from infective diseases. Then there is true diabetes, in which you have the patient thin and weak, generally with greatly increased appetite and with very great thirst. Both of these symptoms may be completely absent in cases of gouty glycosuria. You generally find such patients somewhat thirsty, but there may be no great thirst and no greatly increased appetite. In the case of true diabetes you find the patients are subject to great wasting. The

course of the disease in true diabetes is a short one. It does not, as a rule, run for more than three to six years; although gouty glycosuria may run on for thirty or forty years, as happened in the case of the lady I referred to.

The next point is that I think it is not advisable to be too strict in the regulation of diet. You ought to be strict in cutting off all sugar, and in reducing the carbo-hydrates, such as starch, almost to a minimum; but if you cut them off entirely you run the risk of having your patients take more than you would allow, whereas if you let them have a certain amount you may manage to keep them to the restricted diet.

The next thing is that the best remedy in gouty glycosuria is exercise, and if the patients cannot take exercise they can have massage, and you may give them salicylate of soda; but in cases of true diabetes almost the only drug we can trust to at all is the administration either of opium or one of its alkaloids.

UEBER EIN GLYCOLYTISCHES ENZYM IN DEN MUSKELN.

IN CONJUNCTION WITH J. H. RHODES, L.R.C.P.

(Aus dem '*Centralblatt für Physiologie*,' vom 20. August 1898, Heft 11.)

VOR 25 Jahren hat der Eine von uns (Brunton) den Versuch gemacht, ein glycolytisches Enzym aus Muskeln zu extrahiren durch Maceration des gehackten Fleisches in Glycerin und nachherige Ausfällung mittelst Alkohols.[1] Er hat in dem Präcipitat eine glycolytische Wirkung gefunden, aber nur spurweise. Wir haben neuerdings die Arbeit wieder aufgenommen und Versuche angestellt an dem durch hydraulischen Druck aus frisch geschlachtetem Fleisch ausgepressten Muskelsaft. Dieser Saft, wenn ganz frisch, besitzt eine sehr deutliche glycolytische Wirkung sowohl auf diabetischen Zucker als auf käufliche Dextrose; jedoch verliert er in wenigen Tagen diese Wirkung, ob durch Zerstörung des Enzyms oder durch Ueberführung in ein Zymogen, haben wir noch nicht entscheiden können. Da die Versuche durch die Ferien eine Unterbrechung erleiden werden, machen wir jetzt diese kurze vorläufige Mittheilung. Wir hoffen aber, die Versuche nach den Ferien fortzusetzen und, wenn möglich, den Zusammenhang zwischen Enzymwirkung und Muskelzusammenziehung zu eruiren.

[1] *Brit. Med. Journ.*, Feb. 21st, 1874, *vide antea*, p. 31.

ON THE CAUSE OF THE NON-PRECIPITATION OF OXIDE OF COPPER IN TESTING CERTAIN CASES OF DIABETIC URINE.

(Reprinted from *St. Bartholomew's Hospital Reports*, vol. xvi. pp. 235–239, 1880.)

In testing for sugar in urine, I have frequently observed that on boiling, after the addition of sulphate of copper and caustic potash, or of Pavy's solution, the blue colour of the mixture disappeared, and was replaced by a brownish-yellow one, somewhat darker than that of the urine itself, but without any precipitate whatever being thrown down. When this has been the case, I have generally tested the urine by Moore's test with liquor potassæ alone, in order to ascertain whether sugar were present or not. As a rule, I have attributed little importance to this decoloration without precipitation of oxide of copper, and have considered it to be usually caused by the presence of excess of uric acid, or to some reducing or organic compound of unknown nature. A few months ago, however, on examining the urine of a patient whom I knew to be diabetic, I found to my astonishment that I got no precipitate of oxide of copper, although I got the blue colour of the mixture of urine and cupric solution destroyed, and its place taken by a tolerably bright yellow opalescence. Knowing as I did that sugar was generally present in specimens of this urine, it occurred to me that there might be some other substance present in the urine which kept the reduced oxide of copper in solution. It seemed not improbable that if I were to dilute the urine, I should so lessen the solvent power of this substance, whatever it might be, as to allow of the oxide being precipitated. I therefore took about the third of a test-tube full of water, and added to it a little of Pavy's solution, poured into it about half a drachm of the urine, and boiled it; and this time got an abundant precipitate of yellow cuprous hydrate, clearly showing that my supposition was right, and that the urine contained abundance of sugar, accompanied by some

substance which had the power to retain cuprous hydrate in solution. My patient had been suffering from albuminuria as well as glycosuria, but the albumen had completely disappeared, and the sugar had become greatly diminished under a skim-milk diet. I tested the urine with cold nitric acid, in order to see whether the albumen was still absent, and found that it was so; but I got a purple coloration with the acid, such as is usually attributed to indican. It seemed possible, then, that the substance in the urine which kept the cuprous hydrate in solution was either indican or some substance accompanying it. I have therefore tested a great number of specimens of urine in the out-patient department of St. Bartholomew's Hospital, and I find, when I get a well-marked purple reaction on the addition of cold nitric acid,[1] that the urine will, to a great extent, prevent the precipitation of oxide of copper. The method I have adopted for demonstrating this fact is the following:—I add to about two drachms of the urine half a drachm of syrup of grape-sugar, containing 10 per cent., and then test for sugar in the ordinary way, either with Pavy's solution or with sulphate of copper and caustic potash. I then find that on boiling I get the colour destroyed and replaced by a yellow, but that no precipitate occurs. Not unfrequently I obtained a dark yellow opalescence, which, by its contrast with the blue solution, might at first be mistaken for an actual precipitate; but, on looking through it, it is found that no precipitate exists, and that the fluid is quite transparent though opalescent, almost like a solution of glycogen. Its transparency is perhaps more readily demonstrated by allowing the light to shine through it upon a piece of white paper held behind it. It is then found that the yellow part of the solution allows the light to pass as readily as the blue, and concentrates it as a bright yellow band upon the paper behind. If a comparative experiment be made with a similar mixture of ordinary urine not giving the purple reaction with nitric acid and grape-sugar, or of water and grape-sugar, the difference will be at once perceived, because the part of the tube in which the oxide has been thrown down is quite opaque, so that one cannot see through it; and when the light is allowed to fall upon it, it throws a dark shadow upon the paper behind, while the part of the solution in which no precipitation has taken place allows the light to pass freely. The curious opalescence resembling that of glycogen is suggestive, but I have made no observations at present in this direction. I cannot

[1] This is often extremely well marked in the urine of chlorotic patients.

at present say that indican is the substance which keeps the oxide of copper in solution; indeed, I am strongly inclined to believe it is some substance which may be, and often is, accompanied by indican, but not indican itself. All I can yet do is to mention the non-precipitation of oxide of copper in urines which give a purple reaction with nitric acid, and to draw the attention of the profession to this fallacy in testing for sugar in urine, and to say that one mode of avoiding it is to use more tests than the potash alone; because I found that the presence of this body, whatever it may be, does not prevent the brown colour occurring on boiling urines containing sugar with caustic potash. The other is, in cases of suspected urine, to use only a small quantity, well diluted, along with Pavy's solution, instead of using a mixture of the solution with pure urine.

Urines which give a purple reaction with nitric acid do not all possess an equal power of retaining oxide of copper in solution, although, so far as my experience goes, they all have this to a greater extent than ordinary urine. Not unfrequently, after a mixture of Pavy's solution with urine giving this reaction has been boiled and allowed to stand for a few minutes, it becomes of a dark brown colour, and a precipitate may then occur.

According to Kühne,[1] the amount of sugar present in normal urine varies considerably, but one difference can always be observed between the normal urine richest in sugar, and the diabetic urine poorest in sugar. This difference does not consist in the amount of the reduced cuprous hydrate, but in the precipitation of this substance. In normal urine the cuprous hydrate may be produced, but it is not precipitated, and this, says Kühne, is what must always be carefully noted in the examination of urine for diabetes. Normal urine must, therefore, in addition to sugar, contain substances which, when mixed with free alkali, are able to retain the cuprous hydrate in solution. Cuprous hydrate when once precipitated, is not readily soluble, but certain substances will retain it in solution in considerable quantity if they are present while it is being formed. Ammonia, however, can hardly be the agent by which cuprous oxide is retained in solution in ordinary urine, for although it is produced by heating caustic alkalies with urea, it escapes almost immediately; and as it is found in diabetic urines as well as in normal, it cannot be the substance which retains the cuprous hydrate in

[1] Kühne's *Physiologische Chemie*, p. 510.

solution in normal urine. Moreover, normal urine, when treated with soda and cupric sulphate, does not deposit any cuprous hydrate or metallic copper when treated with dilute sulphuric acid, as an ammoniacal solution of cuprous hydrate would do. Consequently substances must be present in normal urine which are absent in most cases of diabetes, and these substances must be excreted by healthy persons in large quantities, for normal urine will often dissolve ten times as much cuprous oxide as it can itself form by reduction. It is only necessary to add to normal urine measured quantities of diabetic urine, or weighed quantities of sugar, in order to convince one's self that even when the amount of sugar is increased by one-half per cent., and sometimes even by 1 per cent., Trommer's test gives a negative result, if one judges by the precipitation of the cuprous hydrate. This has hitherto always been the case, and the numerous researches which have been made on the excretion of sugar by the kidneys, after feeding with sugar or its injection into the blood, are therefore to some extent valueless, especially as the experiments have generally been made with dogs, the urine of which animals contains enormous quantities of the substances which dissolve cuprous oxide. Of one of these substances we can speak more definitely. It is, according to Winogradoff, creatinine, an alkaline solution of which retains in solution the cuprous hydrate which has been reduced by means of sugar in such a way that it is not precipitated by dilute sulphuric acid. Creatinine, however, is in all probability not the only substance concerned in preventing the precipitation of cuprous hydrate in normal urine. In diabetes these substances which precipitate are generally absent, and Winogradoff found, in fact, that the excretion of creatinine in many cases of diabetes was diminished or completely arrested. But this is not always the case, for there are some kinds of diabetic urine which allow only a part of the cuprous hydrate to be precipitated, and retain another part in solution. Indeed, there are some where the precipitation of cuprous hydrate is absent even when the urine contains 1 to 1½ per cent. of sugar. We can readily see that in such cases, when the amount of sugar sinks under 1 per cent., Trommer's test would apparently indicate the entire absence of sugar. "After many years' observation," says Kühne, "I am inclined to suspect that those substances which retain cuprous oxide in solution are found in those cases of diabetes which run a slow course, and in which, with the exception of the high percentage amount of sugar in the

urine, the symptoms of diabetes are absent or only slightly marked, and the urine retains its normal depth of colour."

In the most typical cases, on the other hand, with excessive secretion of a very pale urine, with a dry skin, and frequently with the formation of cataract, these substances are either entirely absent from the urine or present in very small quantities. Such cases must, therefore, in addition to the increased formation of sugar, be complicated with another pathological process, which consists in the non-formation or non-excretion of these substances. It would be desirable to investigate how far this last process is secondary, and produced through the long imbibition of the tissues with sugar.

The case which I have just narrated serves, I think, to show that the non-appearance of these substances in urine is not due to the long-continued action of sugar on the tissues, as Kühne thinks it might possibly be, but is rather owing to a close connection between their formation and the production of sugar itself in the normal manner in the body; for in this case, while the sugar was present in large quantities, the urine presented the ordinary appearance of diabetic urine, but as the amount of sugar excreted in the urine diminished, these substances again made their appearance.

[NOTE.—To avoid mistakes, it may be well to mention that at the time when this paper appeared the solution then known as Pavy's differed from Fehling's only in containing caustic potash instead of caustic soda, and contained no ammonia. The advance of chemical knowledge and alteration in chemical nomenclature has led me to substitute the term "cuprous hydrate" for "oxide of copper" in several places, in order to avoid confusion to the reader, in this reprint.

A good way of showing the solvent power possessed by some urines is to fill one test-tube about one-third full of urine from a chlorotic patient giving the purple reaction with nitric acid mentioned in the text, and to put in another test-tube a similar amount of water. To each add about a drachm of Fehling's solution, and a few drops of diabetic urine. On boiling these a yellow precipitate appears in the test-tube into which water has been put, but a yellow solution in test-tube with urine.]

THE ACTION OF ALCOHOLS AND ALDEHYDES ON PROTEID SUBSTANCES.

IN CONJUNCTION WITH SIDNEY MARTIN, M.D.

(From the *Journal of Physiology*, Vol. xii. No. 1, 1891.)

In our experiments, we have tested the effect of the series of liquid alcohols on proteid substances, in order to determine whether those higher in the scale differed from those lower. It was *à priori* possible that the results obtained might have some bearing on the physiological action of the alcohols and aldehydes.

The solutions of proteid used were: (1) egg-albumin, containing no globulin, (2) serum-albumin of the sheep, containing a trace of serum-globulin, and (3) a mixture of proto- and deutero-albumose, prepared from Witte's "Pepton."

The method adopted was to drop the solution of proteid from a pipette into six times its bulk of the reagent: thus if 10 c.c. of solution were used, it was dropped into 60 c.c. of alcohol or aldehyde; if 5 c.c., it was dropped into 30 c.c.

The action was tested in the following manner:—

a. It was first noticed whether the reagent precipitated the proteid or not.

β. Whether the precipitate, if it occurred, was rendered insoluble after remaining some time under the alcohol or aldehyde. The solubility after treatment was tested by filtering off the precipitate, allowing the reagent to evaporate from the proteid, and testing how far this was soluble in distilled water.

γ. Whether any change of colour occurred in the precipitate.

Action on Egg-albumin.

1. *Of Alcohols.*

1.	Ethyl	Precipitate egg-albumin and coagulate almost completely in 4 days.
2.	Propyl	
3.	Methyl	Same as above, but coagulation not so complete.

4.	Isobutyl	Precipitate and coagulate, but to less extent than preceding, after 4 days.
5.	Isopropyl	
6.	Tertiary Butyl	
7.	Amyl	Albumin solution sinks to bottom of alcohol, becomes cloudy in 24 hours, and partially coagulated in 4 days.
8.	Heptyl	Albumin solution falls to bottom of alcohol, which does not precipitate nor in any way change it.
9.	Octyl	
10.	Allyl	Precipitates egg-albumin at once, and coagulates it completely in 42 hours.

The results therefore may be stated as follows: the precipitating and coagulating power of the alcohols are in the order mentioned, the most active being placed first, with the exception of allyl alcohol, which is the most powerful of all. It precipitates and coagulates egg-albumin completely within 42 hours. Ethyl, propyl, methyl, isobutyl, isopropyl and tertiary butyl alcohols do not differ greatly in coagulating power, while amyl alcohol is a partial coagulater, and heptyl and octyl have no effect on egg-albumin. For all practical purposes therefore the order of coagulating power of the alcohols on egg-albumin is as follows:—

1. Allyl alcohol.

2. A group containing ethyl, propyl, methyl, isobutyl, isopropyl, and tertiary butyl alcohols: which are all active coagulaters, and do not differ markedly in their action.

3. Amyl alcohol: intermediate between the preceding and following group.

4. Group containing heptyl and octyl alcohols.

2. *Of Aldehydes.*

1.	Acetaldehyde	Precipitates egg-albumin white, turns it brown in 24 hours, and causes almost complete coagulation at the end of 4 days.
2.	Propyl aldehyde	Precipitates: turns it slightly brown, and causes nearly complete coagulation at the end of 24 hrs.
3.	Isobutyl aldehyde	Partially precipitates at once: completely precipitates, without turning proteid brown, in 24 hours; albumin being mostly coagulated.

Acetaldehyde is about equal in coagulating power to ethyl and propyl alcohol; the action is, however, evidently quite different, since aldehyde turns the proteid brown. Propyl aldehyde is about equal in coagulating activity to acetaldehyde, while isobutylaldehyde has a slower action, and does not, like the other two aldehydes, turn the egg-albumin brown.

Action on Serum-albumin.

Of Alcohols.

1. Methyl 2. Ethyl 3. Propyl	Precipitate and almost completely coagulate serum-albumin after 23½ hours.
4. Isopropyl	Precipitates; most of albumin coagulated in 23½ hours.
5. Tertiary butyl	Precipitates, but after 23½ hours standing, most of precipitate is soluble in water and coagulable by heat.
6. Isobutyl 7. Amyl 8. Heptyl	Do not coagulate. Isobutyl and amyl alcohols make the solution of albumin cloudy, isobutyl to a greater extent than amyl. Heptyl alcohol has no effect whatever.

As regards this action on serum-albumin these alcohols may be arranged in the following order; the most active being placed first.

1. A group containing methyl, ethyl, and propyl alcohols.
2. Isopropyl alcohol: almost as active as those of preceding group.
3. Tertiary butyl alcohol.
4. Isobutyl, amyl, and heptyl alcohols, the last having no effect whatever on serum-albumin.

Of Aldehydes.

Acetaldehyde Propyl aldehyde Isobutyl aldehyde	Do not precipitate or coagulate serum-albumin. Aldehyde and propyl aldehyde turn the solution of albumin brown: isobutyl aldehyde has no evident effect.

Action on albumoses—a mixture of proto- and deutero-albumose.

Of Alcohols.

1. Methyl 2. Ethyl 3. Propyl 4. Isopropyl 5. Tertiary butyl	Cause a precipitate, which is quite soluble after 42 hours.
6. Isobutyl	Causes a cloudiness in solution. No coagulation.
7. Amyl 8. Heptyl 9. Octyl	No effect on the albumoses. Does not precipitate. A temperature of 40° C. for 48 hours does not produce any further effect of heptyl alcohol on albumoses: but amyl causes a slight cloudiness.
10. Allyl	Precipitates slowly, and renders insoluble in 42 hrs.

Of these alcohols, then, allyl is the only one that renders the albumoses insoluble.

The group of methyl, ethyl, propyl, isopropyl, and tertiary butyl alcohols precipitate the albumoses without coagulating them.

Isobutyl alcohol partially precipitates, while amyl, heptyl, and octyl alcohols have no action whatever.

Of Aldehydes. No precipitation caused.

Acetaldehyde	Turns albumose solution brown in 19 hours.
Propyl aldehyde Isobutyl aldehyde	Do not affect solution of albumoses.

Placed in the incubator at 40° C. for 48 hours no further change is observed.

Remarks on the results obtained. The general result obtained as to the effect of alcohols on proteids is that the higher alcohols in the series have a less powerful action in precipitating and coagulating proteids than the lower ones. Allyl alcohol is an exception. It is a powerful coagulant of egg-albumin, and is the only alcohol which coagulates albumoses.

THE INFLUENCE OF STIMULANTS AND NARCOTICS ON HEALTH.

(Reprinted, by permission of the publishers, from *The Book of Health*, Messrs. Cassell and Co., Ltd., London, 1884.)

Introductory—The Value of Alcohol as a Food—The Effects of Alcohol—The Causes of Intemperance—Forms of Alcohol—Diseases Resulting from Excessive Use of Alcohol—Hereditary Effects of Alcohol—Alcohol in its Relations to Crime, Lunacy, and Pauperism—Ether—Opium—Chloral—Indian Hemp—Tobacco—Betel-nut—Tea—Coffee—Chocolate—Cocoa—Guarana—Cola-nut—Coca—Kava—Beef-tea.

In nearly every country of the world, and among all races, excepting the most savage, we find that the practice of taking certain substances which cannot be regarded as food, but yet afford enjoyment to the consumers, is almost universal. Even the most savage races, who are unable to obtain such substances for themselves, possess a liking for them, which they show as soon as they get an opportunity of obtaining them. These substances are at first sight very various in their nature, but on examination are found to resemble one another in many respects.

They may be classed into stimulants and narcotics. By stimulants, we mean those things which seem to increase our vital powers for the time being, and thus to give us feelings of greater strength or comfort. By narcotics, we mean such substances as lessen our relationship with the external world. When used to a slight extent, narcotics simply afford pleasure by lessening the restraining or depressing effect which external circumstances exert upon the individual. Small quantities thus allow freer play to fancy, and produce a joyousness and thoughtlessness like that of a child whose animal spirits have not been depressed by the wear and tear of life; but in large quantities they abolish all the mental faculties, and render the person who has taken them completely torpid, and incapable of any voluntary thought or action. The effect of such powerful substances as these, both on individuals and

communities, is necessarily enormous, and their abuse may lead, not only to individual, but also to national disaster.

The most important of these stimulants are alcohol—in its various forms of wines, spirits, and beer—tea, coffee, and cocoa. The most important narcotics are, alcohol again, in its different forms, tobacco, opium, chloral, and Indian hemp. Besides these, there are a few others, such as cocoa, amanita, and datura, the use of which is not so general. From this enumeration it will be seen that the stimulants and narcotics are connected by alcohol, which comes into both categories; and, indeed, most of the narcotics are stimulants when given in small doses, although the converse is hardly the case, and we can scarcely say that all the stimulants are narcotics when given in large doses. In order to understand the relationship, as well as the differences, between stimulants and narcotics, it will probably be best to consider, first, the way in which alcohol acts upon the human body, and afterwards to compare its action with that of opium, tobacco, tea, coffee, etc.

Alcohol and its Effects.

At first sight, it appears very odd that men should put into their mouths a poison which may steal away their brains; but for such an universal custom there must be some powerful cause. When we proceed to ask—Why do men do it? we find ourselves at once face to face with the still larger question—Why do men do anything? And to this we must answer, that men do things either to obtain pleasure or to avoid pain. Nor are those motives confined to men alone; for the obtaining of pleasure and the avoidance of pain are, so far we can ascertain, the great motives of all action in the lower animals as well. These motives are closely connected with the health and welfare of the individual; and without them, individuals would die and the race would perish. The feeling of pleasure is associated with those acts or conditions which are beneficial to the individual or to the race, and pain with those which are hurtful. The feeling of pleasure is often a sufficient incentive to actions which are necessary for the individual's welfare, but Nature has so arranged it that when the desire for pleasure is disregarded, the feeling of pain succeeds as a further stimulus to drive the creature on to the necessary action. Thus, in most persons and animals, the pleasure which is associated with

the gratification of the appetite induces them to take the food necessary to sustain life; but if this call be not attended to, the pains of hunger succeed to simple appetite, and drive the person or animal to endure the greatest fatigue, or to brave the greatest dangers, in order to satisfy the wants of nature. The same is the case with drink, which is even more necessary to life than food; and while slight degrees of thirst afford pleasure through the delicious sensations experienced in quenching them, their greater degrees are among the most intense torments which it is possible to endure. But dreadful though pain may be to the sufferer, it is in itself beneficial, by giving warning against those conditions which would be injurious, and by inducing the individual to avoid them. The effect of its absence is sometimes seen in maniacs, in whom the sense of pain is lost, and who consequently will sometimes thrust their hands into the fire, and will watch with delight their blazing fingers; while a healthy child, when once burned, dreads fire, and so avoids the destruction which the maniac courts.

Of pleasure and pain, then—the two great stimulants to action—the one, pleasure, is closely associated with the well-being or health of an individual; the other, pain, is so closely connected with ill-health, that we usually give the name "disease," or want of ease, to that condition. But all pleasure is not summed up in meat and drink, and so we must try to examine more closely still into the conditions of pleasure. We will find ourselves aided in this attempt by considering the phrases in which the common experience of mankind has translated pleasurable sensations into language. Some of the most common expressions are—"His heart beat high with hope," "His pulses throbbed with joy," "A thrill of pleasure shot through his veins." In all these expressions we see that pleasure and pleasurable sensations are closely connected with the increased activity of the heart and circulation; and this, again, is one of the conditions of health and strength. Even meat and drink, pleasure-giving though they may be, only give strength when they have been converted by the subtle chemistry of the body into blood, and are carried by the circulation to every part of the system; for the food we eat does not go directly to the brain, to supply the waste occasioned in it by the thoughts, fancies, desires, emotions, and will, of which it is the organ; nor does it reach directly the muscles of the arms and legs, to give them the strength for long-continued work: it only reaches them through

the blood-vessels. It is from the blood that the brain, the muscles, and every part of the body, derive the nourishment appropriate to each. Huxley well compares the blood to a stream running through a village, from which every individual may take as it passes him (but only opposite his own door) those things which he needs, and cast into it all the refuse which he wishes to be carried away. The stream is the blood, its bed is the vessels, and the inhabitants of the village are the various parts of the body. If from any cause the course of this stream should be languid, the inhabitants of the village would suffer proportionately; and if it should be completely dried up, they would necessarily perish. Nor would the condition be altered in the least if supplies to any amount of the things which they required were accumulated at other points in the stream, so long as it failed to bring them to their doors. It is only as the blood passes through the tissues themselves that they are able to receive nutriment from it, and discharge into it the waste products of their functional activity; and when the blood ceases to pass through them, they perish. It makes no difference to them that the supplies of nutritive material may be in other parts of the body, so long as these are not brought to them by the blood. Increased activity of the circulation brings to the tissues increased supply of blood, enables each tissue to perform its function more easily and more perfectly, and thus conduces to the welfare of the individual, increases his strength and powers, and at the same time gives him sensations of pleasure. The increased nutrition betrays itself in the man's appearance: the blood mantles more richly in his cheek, giving it a ruddier hue, and the increased power of his nerves and muscles renders his step free and his head erect. Pleasure gives power, and power gives pleasure. The success of an army in a skirmish gives them pleasure, and the pleasure gives them power not only to attack the enemy more vigorously in the next battle, but to resist the ravages of disease. Painful sensations, on the other hand, are associated with a depression of the circulation. The common experience of mankind has embodied this fact also in language. We hear of men's hearts failing them for fear, and of their hearts sinking within them from painful news. Painful impressions, physical or mental, weaken the pulse, and severe physical injuries or mental shocks may stop the heart completely. Pain evidences itself in the appearance and actions. A weakened circulation causes the brain and the muscles to be more imper-

fectly nourished; the cheek becomes pale, the mental faculties are dull, the step is languid and feeble, and the head is bowed down. Just as pleasure gives power, and power gives pleasure, so pain and sorrow give weakness, and weakness gives pain and sorrow. Soldiers are not only rendered ashamed and sorrowful by defeat, but they are actually weakened, so that they are not only able to resist less perfectly a second attack of their enemies, but are more likely to succumb to sickness and disease. We see, then, that pleasure and power go together with an active circulation of the blood, and that pain and weakness are associated with a languid circulation; that pleasure strengthens the circulation, pain and sorrow depress it. We see also that, on the other hand, if we can strengthen the circulation, we produce pleasure or diminish pain; and if we diminish the circulation, we lessen pleasure and may cause pain. We ought, perhaps, more appropriately to say nutrition than circulation, inasmuch as there are certain exceptions to the statement which we have just been making; but, for the present, we may leave these exceptions aside.

Food and drink increase the strength of the circulation; or, in other words, they stimulate it. The effect of this stimulation makes itself evident not only in the pleasure which is felt from the gratification of the appetite, but in the more cheerful view which the person is likely to take of things in general after a good meal. The effects of a depressed circulation are seen in the gloomy view of things which one is apt to take if weakened by long fasting, or still more if affected with nausea from a sea-voyage, or with the condition which the Greeks so wisely associated with bile in giving to it the name of "melancholy." A vigorous circulation produces or increases pleasure, and diminishes the effect of such external circumstances as cause pain or sorrow. On the other hand, a feeble circulation tends to cause pain, mental or bodily; it aids the action of depressing external circumstances, and lessens the effect of favourable externals to produce pleasure. Such being the case, we would naturally expect not only human beings, but the lower animals, to obtain by all means in their power a vigorous circulation, and to seek after the conditions which favour it; and such is actually the case.

It must not be forgotten, however, that the brain is the organ of the mind and the seat of thought and sensation. Vigorous circulation in it may, to some extent, produce a similar effect to increased circulation through the body generally, and thus substances which

increase the circulation in it may become most powerful and useful stimulants, although their action on the general circulation is very slight.

One of the most powerful stimulants to the circulation with which we are acquainted is heat, and one of the most powerful depressants is cold. Exposure to long-continued cold will make the heart beat more feebly, until at last it stops altogether; although a temporary exposure of the surface of the body to a cool breeze or to a dash of cold water may actually increase the circulation, and cause strength and pleasure. Active exercise also increases the circulation, and gives pleasure, although when carried to the extent of fatigue it may render the pulses languid, and produce discomfort or pain. Light is another stimulant to the circulation; and although it is now many centuries since a writer observed that "it is a pleasant thing for the eyes to behold the sun," it is only of late years that the way in which light acts upon the body has been even partially investigated. Throughout the whole animal kingdom we notice the tendency to seek the conditions favourable to the circulation—to rest in a cozy nook by the fire or bask in the sun's rays; to frisk and gambol about while young, and to run, to chase, to struggle, to fight, in middle age. Among human beings who have become too old for such exercises, or are prevented by social obligations from indulging in them, we still find the tendency to seek excitement in the mimic struggle of a game of whist or chess, or in the sympathetic emotions excited by a novel or the stage. All the things just mentioned might be classed as stimulants: indeed, mental emotion is one of the most powerful stimulants that we know. Under the influence of hope, for example, the man or animal who has been wearily toiling for hours over desert sands, and is ready to sink from fatigue, will at once seem imbued with new life, and will hasten to the well which is visible in the distance. But should the well be dry, disappointment and despair at once rob both man and animal of their strength; they throw themselves down in utter exhaustion, and their mental emotions even combine with physical conditions to accelerate their death.

But although all the influences, physical and mental, already mentioned, which increase the power of the circulation, and the nutrition and welfare of the individual, might be classed as stimulants, the name is generally restricted to substances which produce such an effect when they are eaten or drunk, and which

cannot be reckoned as food, either because they contain no nutriment at all, or such a minute quantity of nutritious material as to be unimportant. Every action which takes place in the body causes a certain amount of waste; and, indeed, it is only by the combustion of certain materials in our organisms that the mental and bodily energy necessary for our thoughts and acts is evolved. Man and animals have very often been compared to steam-engines, and the comparison is a very good one. Complicated though the mechanism of the steam-engine may be, it is infinitely less complex than that of the animal body; and the comparative simplicity of the engine helps us more easily to understand the workings of the body. In both, the combustion of fuel is the source of movement, and both require their various parts to be repaired when worn out by use. In the steam-engine the fuel is coal or wood, and iron or brass is the material used for repair. In the body the fuel is starch, sugar, fat, and proteids, and some of these substances, along with salts, are also used as material for repair. The body differs from the steam-engine not only in its composition, but in its being steam-engine, stoker, driver, and smith, all in one: it goes, it stops, it feeds itself, and repairs its parts as they are worn out by action. The substances which serve as fuel, or as material for the repair of the body, are foods; stimulants do not necessarily serve either as fuel or as material for repair, although some may do so to a certain extent, and others may lessen the need for food by diminishing the wear and tear, just as a free supply of oil lessens the wear and tear in a steam-engine.

The question whether alcohol is a food or not is one which has given rise to very great discussion, and has been debated very hotly. If we examine the question dispassionately, we shall probably come to the conclusion that alcohol is a food, although for healthy persons it is not a convenient food. No one doubts that sugar is a food, although few people would ever dream of attempting to live entirely on sugar. If they did try to do so, they would fail, for sugar alone is not capable of supporting life, although it forms a useful addition to other food. A steam-engine might be kept working for a considerable time with coal, but the iron and brass rods and cranks cannot be mended with coal; and if they were worn out, no amount of fuel in the furnace could make the engine go. At the same time, all the metal parts of the machinery might be perfect, but the engine would not go without fuel in the furnace. In the same manner, a man may do a certain amount of work upon

sugar as a food, but if he were to take it alone, he would soon die, inasmuch as it would not supply the material necessary for the repair of the body. Nor would an ounce or two of meat and fat be sufficient for daily food, for though it might be sufficient to repair waste, it would not supply sufficient fuel to maintain activity in all the various parts of the body. In the absence of sufficient fuel, the body itself would be consumed and waste away, and death would result. But although the fat, meat,[1] and sugar would each by itself be unable to support life, the three combined would do so well, and a combination of food, each imperfect in itself, really constitutes a perfect diet. Just as the coal supplied to the steam-engine is burned up in the furnace, passes off from the funnel in the shape of invisible gases, and leaves behind only a small residue of ashes, so do we find that in the animal body the foods which we introduce disappear, and the products of the decomposition are partly given off as carbonic acid by the lungs, and partly by other excretory channels, such as the kidneys, bowels, and skin. But if the coal is mixed with lumps of earth which do not serve as fuel, they do not undergo combustion, and are raked out by the stoker comparatively unchanged. Other substances, likewise, which are not foods, but which we may eat or drink without any serious injury, instead of undergoing combustion, pass out of the body comparatively little changed. This character aids us in distinguishing between substances which are foods and those which are not. Water, which is by some reckoned as food, does not undergo combustion in the animal body, any more than it does in the steam-engine. Without it, neither the body nor the steam-engine could go on, but it does not supply the energy in either case, like the fuel in the furnace or the food in the body.

When we now come to ask whether alcohol is a food, we find that it agrees with sugar in many respects. It appears to undergo combustion in the body, for it is not excreted, excepting when taken in large quantities; and even sugar, when eaten in excess, is excreted as sugar, insufficient time having been allowed for its combustion: very much in the same way as if a stoker piled on coal so quickly that a good deal of it fell into the ash-pit before it could be consumed. A great deal has been made of the fact that when quantities of alcohol are taken some part is excreted

1 This is true only of the small quantities mentioned in a preceding sentence. In large quantities meat alone will support life, but it is not such convenient food as a mixed diet.

unchanged as an objection to the claim of alcohol to rank as a food, but this objection, as we have just seen, is not valid. The chief claim of alcohol to the name of food, however, is that although, like sugar, it will not support life when given alone, it will help to do so if given along with other foods. Thus Hammond observed, that when he put himself upon an insufficient diet he lost weight daily, but when he added to this diet a little alcohol, instead of losing, he began to gain weight. We find, too, especially in cases of disease, that people will often live a considerable time with hardly any other food than alcohol in one of its forms. We may consider, then, that alcohol is a food; but whether it is a convenient food or not is quite a different question. Sulphur burns easily, and might be used as fuel. Because it burns so easily it was formerly employed to tip sulphur matches, and there it was in its place; but it is also a popular remedy for chimneys on fire, because when thrown into the grate the sulphurous acid which it produces when burnt passes up the chimney, and puts out the blazing soot. It burns itself, but instead of aiding the combustion of the soot it prevents it. So it is with alcohol. Alcohol undergoes combustion in the body, but at the same time it tends to lessen the combustion of other things. In healthy people this is, of course, a disadvantage, because it is by the combustion of our food that our strength is maintained. Alcohol is, therefore, for healthy people, a very inconvenient form of food. In fevers the case is different, because there the body is burning away too rapidly, and alcohol has the double advantage of retarding this process, as well as of acting itself as a food. In wines, beer, and spirits, alcohol is contained, but in each of them it is mixed with other things, which modify its action as a food. On comparing these substances, we see at once that the action of alcohol as a food and as a stimulant are not connected. If we take, for example, a quantity of beer and of brandy containing the same amount of alcohol, we will find that the beer is more nourishing, but the brandy is more stimulating. The stimulating power of alcohol, indeed, is considerably affected by its dilution. To a person who is fainting we would give brandy raw, and would not think of mixing it with a large quantity of water. Experience has shown, indeed, that a table-spoonful given pure would have more effect than double the quantity in a tumblerful of water. This shows us that concentration modifies the effect of alcohol. In considering its action, we will have to distinguish between the effect it produces locally on

those parts of the body with which it comes in contact, and its general action after it has been absorbed into the blood. We notice a very marked difference between the effect of brandy and brandy-and-water in the mouth. Pure brandy retained in the mouth for a short time—as, for instance, in relieving toothache—causes a sensation of burning, and when we look at the inside of the cheek, we see that it has become slightly whitened and corrugated. This feeling of burning and the whitening of the mucous membrane lining of the mouth are due to the effect of alcohol on the tissues. If we mix a little spirit of wine with white of egg (or albumen, as it is termed by chemists), we find that the albumen becomes more opaque and less fluid—that it is, in fact, coagulated. If we boil the white of egg it will also be coagulated by the heat. But we notice a difference between the coagulation produced by alcohol and by boiling. The coagulation produced by alcohol is less perfect, and if we add water to the coagulum, it will re-dissolve, whereas the albumen coagulated by heat remains unaffected by the water. The whiteness of the mucous membrane in the mouth after brandy has been held in it is due to the albuminous substances in the mucous membrane being partly coagulated by the alcohol (*vide* p. 69); but the whiteness and burning soon pass away, for this coagulation is rapidly removed by the circulation. Boiling water would produce a similar whiteness in the mouth, but it would not pass away; and the intense burning pain would also be permanent, while the burning feeling caused by alcohol is very fleeting.

But before passing away from the mouth, we must notice that the brandy causes a profuse secretion of saliva. The saliva is secreted by a gland situated at a little distance from the mouth, and connected with the mouth by a narrow tube, or duct, through which the secretion flows. The orifice of this tube is very narrow, and opens in the form of a little papilla, which forms a kind of valve, so that while the saliva can readily pour into the mouth, fluids from the mouth cannot enter the duct. Consequently, the brandy cannot reach the gland, and yet, as the profuse flow of saliva shows, it affects it profoundly. It acts both on the mucous membrane and on the gland, but its action upon the two is of a different kind. It comes directly into contact with the mucous membrane, and thus affects it directly; it does not come into contact with the gland, and therefore can only affect it indirectly, by what is termed reflex action.

Reflex action plays a very important part in the body, and in order to understand the effect of alcohol, we must have a clear idea of what reflex action means. Here, also, a comparison may help us to form a more definite idea of the subject in hand. In some houses, where the outer gate or door is at some distance from the hall, the visitor pulls the door bell, but instead of the servant going to the door and opening it, he pulls a handle, which acts upon the distant door. In the case of reflex action, the servant is a nerve centre, the door bell is a sensory, or afferent, nerve going to it, and the handle which the servant pulls to open the door is a motor, or efferent, nerve passing from the nerve centre to the part of the body which is to be set in action. The part corresponding to the door may be either a muscle or a gland. To apply this to the saliva, we may say that the brandy is the visitor, the door bell which he pulls is the sensory nerves of the mouth, the servant is a part of the brain, and the handle which he pulls is a nerve which goes to the salivary gland. When everything is quiet, no secretion takes place; but when a stimulus is applied to the end of the sensory nerves by the brandy taken into the mouth, it is passed up the sensory nerves to the nerve centre, thence down the efferent nerves to the gland; the gland begins to secrete, and the saliva flows freely. It is evident that a reflex action of this sort may be stopped in several ways. If the door bell be broken, the servant will not be warned of the visitor's presence; if the servant be asleep, he will pay no attention to the warning given by the bell; if the handle be broken, the door will not open, however much he may pull at it; and if the servant has been rung up a number of times violently, he may by and by get tired, and will not answer to a gentle pull. Something like this we find in the case of alcohol also, for the morning after too great an indulgence in spirits the mouth is very apt to be dry. It is perhaps hard to say what part is here in fault, but most probably it is the nerve centre, which has been partly stupefied by the alcohol, and no longer responds to the ordinary slight stimulus given by the motions of the tongue and lips.

When we follow alcohol from the mouth to the stomach, we find that there too it produces a sensation of warmth. If taken in very large quantities, it would, no doubt, produce the same whitening and burning that one notices in the mouth, but the stomach being so much larger than the mouth, a very large quantity would be required to produce this effect—a quantity so

large as probably to kill the person at once—for reflex action occurs from the stomach as well as from the mouth; and one of the organs which is very closely connected with the stomach in this way is the heart. A blow on the stomach will sometimes cause instantaneous death, and a very large quantity of spirits taken at a draught has a somewhat similar effect, producing reflexly great depression, or perhaps even stoppage of the heart's beats. In this case, the impression made by the brandy is transmitted by the sensory nerves of the stomach up to a nerve centre, known as the medulla oblongata, at the upper end of the spinal cord, and thence down by the so-called inhibitory, or restraining, nerves to the heart.

When taken in smaller quantities, however, the effect of brandy is quite different. The impression it makes on the stomach is transmitted to the medulla oblongata by the sensory nerves, but instead of being sent down the inhibitory nerves, it is transmitted by the stimulating nerves of the heart, and thus increases the rapidity and strength of its pulsations. Closely associated, in the medulla oblongata, with the nerve centre governing the heart, is one which regulates the size of the vessels. This is also affected reflexly by alcohol. The consequence of this is that the vessels in the stomach itself dilate; its mucous membrane becomes rosy-red, and secretes freely; the vessels throughout the body also dilate; the skin is covered with a rosy blush; a free supply of blood is sent to the brain; thought becomes more ready, and bodily exertion more easy. The increased supply of blood to the stomach, to the skin, and to the nervous system, have beneficial effects on these parts, which we shall presently consider more in detail.

But it must be remembered that the effects just mentioned are reflex—that is, are due to the local action of the alcohol on the stomach before any of this has been absorbed; and we shall afterwards have to consider the way in which these are modified by the effect of the alcohol on the different parts of the body, after it has been absorbed and carried to them by the blood. Effects very much like these may be produced by a draught of any warm liquid which is pleasant to the taste, although it contains no alcohol, and will even be produced to a considerable extent by hot savoury food. They come on so shortly after the introduction of the alcohol, or of the food, or of the warm drink into the stomach, that we can hardly suppose that there has been time for absorption; and besides, we find that, although all these three things produce similar

effects at first, their action is considerably modified after time has been allowed for their absorption, and conveyance by the blood to the various parts of the body.

Let us now examine the effect of alcohol on the stomach itself in moderate quantities. Although an instrument has been recently devised by which the interior of the stomach can be seen, it is still extremely difficult to use, and previous to its invention it was impossible to see what was going on in the interior of the stomach, except under exceptional circumstances. A number of years ago, however, a Canadian hunter, named Alexis St. Martin, met with an accident by a charge of shot entering his side and penetrating his stomach; the wound healed, but the stomach was adherent to the side, and an opening remained through which one could look in, and see what was going on in it. A similar condition was afterwards established in dogs by Bernard and Blondlot, and by means of observations made in this way the effect of various conditions on the stomach has been ascertained. On looking into the empty stomach, the mucous membrane which lines it is seen to be moderately pale and dry. It has a somewhat velvety look, and under the microscope the velvety pile is seen to consist of numerous minute tubes, standing close to each other, and filled with cells, which secrete the gastric juice. It is to this juice that the digestive power of the stomach is due. It does not dissolve all kinds of food, but only proteids, the starches and fats being dissolved by the secretions from the other parts of the intestinal canal. When the mucous membrane of the stomach is slightly stimulated by touching it with a feather or a glass rod, or by the introduction of food, its vessels dilate, its colour at once becomes of a rosy-red, and the gastric juice which is to dissolve the food is rapidly secreted, and stands in beads on the surface. These soon coalesce, and run in little streams along the membrane.

This is the effect of a slight stimulus on a healthy stomach, but when the stimulus is too powerful the result is quite different. If the rod be rubbed too hard over the interior of the stomach, the vessels which had become dilated by the gentle stroking contract, the mucous membrane becomes pale, the secretion of gastric juice is arrested, and a ropy mucus is secreted instead; if the irritation be pushed still further, signs of nausea appear, and vomiting may occur.

These are the effects of over-irritation on the stomach previously healthy; but in order to understand thoroughly the effect of

alcohol, we must consider that the stomachs of those who take it are not always healthy. The persons may be weak and debilitated; then their stomachs will share in the feebleness of the body generally. In those stomachs which are below par, a stronger stimulus than usual may be necessary to produce a healthy secretion. In others the stomach may be already irritable, and the stimulus which in a healthy stomach would be only sufficient to cause a proper secretion of gastric juice may produce on the irritated mucous membrane the same effects as an over-stimulus on a healthy one, leading to a secretion of mucus, nausea, or vomiting. The secretion of gastric juice by the walls of the stomach is only the first part of the process of digestion in it. In the mouth the food is broken down by mastication, and is mixed with saliva; this both renders it more easy to swallow, and partly changes the starch into sugar. This is readily observed by simply chewing a piece of dry bread for a little while, when it will be found to acquire quite a sweet taste. When the food is swallowed and reaches the stomach, it acts as a gentle stimulus to the gastric mucous membrane, and causes a secretion of gastric juice in the way just described. This juice dissolves the albuminous matters, such as meat, fish, eggs, cheese, and the albuminous constituents of milk; and it renders more soluble the gelatinous substances contained in sinew. It does not dissolve the starchy parts of our food, but the digestion of these continues to be carried on in the stomach by the saliva swallowed with them. The solvent principle of the gastric juice is pepsine, a substance which is insoluble in alcohol, and can be precipitated from gastric juice by mixing it with alcohol. It only acts in solution; and gastric juice mixed with much alcohol has no digestive power. Even when the quantity of alcohol is insufficient to precipitate the pepsine, it seriously impairs its digestive properties. We can readily see, then, that a large quantity of alcohol will be very detrimental indeed to digestion, although a small quantity may be innocuous, or even beneficial. When the quantity is small, so as not to over-excite the stomach, it will induce healthy secretion of gastric juice, and will also stimulate the movements of the stomach, which tend to mix up the food with the gastric juice, and thus aid digestion. Its effect upon the movements of the stomach is not unfrequently evidenced by its tendency to cause the expulsion of any gas which may be present in the stomach when it is taken.

In persons below par, the addition of a little alcohol to the food

may be of advantage; and Paul showed his wisdom in recommending Timothy to take no longer water, but a little wine "for his stomach's sake, and his often infirmities." A condition of this sort is sometimes met with in persons who are otherwise perfectly healthy, but who are depressed by town life and hard work. During their holiday they feel perfectly strong, and have no need of alcohol; but when they return to hard work in town, they find their strength flagging, although they do not notice any derangement of their digestion. Their appetite may be smaller, but such food as they take appears to be perfectly well assimilated; they do not appear to suffer from dyspepsia, and the diminution of strength is the only thing they notice. Sometimes, in consequence of this, they go on trying the experiment of living without alcoholic stimulants for months together, but are forced by increased weakness to have recourse to them again. They then find that a very small quantity of wine or beer taken with their food is sufficient to bring them up to par, and enable them to go comfortably on with their work. In one case described to me by Dr. Mitchell Bruce, a gentleman found that he invariably suffered from diarrhœa unless he took some alcohol with his food. A little brandy-and-water, however, taken with his meals invariably stopped it. In all probability, the explanation of this occurrence is that food alone did not sufficiently stimulate the secretion of gastric juice; digestion in the stomach was therefore slowly carried on, and either the undigested food itself, or the products of its decomposition passing out from the stomach into the intestine, caused irritation and diarrhœa. The alcohol, stimulating the secretion of gastric juice, quickened digestion, and thus restored the healthy condition. In the old and feeble, alcohol taken with meals may in moderation be very useful, and may sometimes be so also in men otherwise healthy and strong, but who are exhausted by over-work and fatigue.

But in excess alcohol is doubly injurious at meal-times. By causing over-irritation of the mucous membrane it diminishes the secretion of healthy gastric juice, and causes the secretion of mucus, which, instead of aiding, interferes with digestion. Besides this, the alcohol itself interferes with the action of the gastric juice. So much, indeed, is digestion retarded that I remember on one occasion seeing a man suffering from delirium tremens vomit undigested matters which he told me were the remnants of a dinner he had had four days previously.

We will now pass on to consider the effect of alcohol upon the

circulation and nervous system. We have already mentioned that a quantity of strong alcohol swallowed at once will depress the heart, and produce shock or collapse, in much the same way as a violent blow in the epigastrium. Small quantities, on the other hand, stimulate the heart, increase the circulation, give a sensation of comfort and strength, and may enable the person, for the time being, to do more work, bodily or mental; but these effects are modified by the action of the alcohol after it has been absorbed. It has already been said that all the powers of the body are maintained by processes of combustion. Long ago it was supposed by some that the stomach was the furnace of the body; others, again, supposed it to be the liver; others, again, the lungs. Now we know that combustion takes place in all parts of the body. This combustion cannot occur without the presence of oxygen, and the oxygen of the air cannot reach the remote parts of the body directly. It is, however, carried to them by the blood, which takes up oxygen in the lungs, and, carrying it to the various parts of the body, gives it off readily to the tissues. Binz, Schmiedeberg and others have shown that one of the effects of alcohol is to lessen this oxygen-carrying power of the blood, and thus to interfere with the combustion which takes place in the various parts of the healthy body, and is so necessary to the maintenance of their functions. When the quantity of alcohol is small, this effect will be but slight, and may be much more than compensated by the increased circulation of blood which alcohol causes; but when the proportion of alcohol in the blood comes to be considerable, the importance of this action is greatly increased, and it may cause very marked results indeed: *e. g.* when alcohol is taken frequently for a length of time, as in chronic drunkards. In these persons the impaired combustion may lead to the accumulation of fat, resulting in obesity, or to the partial conversion of other tissues of the body, such as the muscles, into fat. This produces weakness, and as the heart becomes affected in common with other muscles, the circulation fails and life is shortened. As the alcohol flows with the blood from the vessels and is carried by them to the nerve centres which govern them, the vessels on the surface of the body dilate, and the warm blood rushes freely through, producing a comfortable glow. This effect may be often observed very plainly by looking at the hands before and after alcohol has been taken. The skin, which was at first pale, mottled, or even bluish from cold, becomes, as the vessels dilate, of a clear rosy red. This colour is uniformly distributed, showing that all the

minute capillary vessels have become enlarged; and the veins, which were before small, dark, and contracted, become full, large, and pale blue, showing that the blood is now circulating freely through them, and instead of being very dark has become much lighter in colour, or, in other words, more arterial. The warm blood coursing freely through the skin gives a sensation of warmth, for it is through the skin that we are conscious of heat or cold, and the temperature in other parts of the body may be very high, and yet we are unconscious of it if the skin is cold. Thus it has been found that the temperature of the interior of the body has been very many degrees above the normal in cases of cholera where the patient was apparently icy cold, and if we put a thermometer in the mouth of a person suffering from an ague fit, we will find it indicate fever-heat, although the patient is shivering from cold and crouching over the fire in the vain effort to warm himself. The cutaneous vessels of the skin having contracted, they prevent the hot blood from the interior of his body from circulating through the skin, and so we see him pinched, pale, and shivering. But so soon as this spasm relaxes and the fevered blood again circulates through the skin its high temperature is at once perceived by the cutaneous nerves, and the patient passes suddenly from a feeling of excessive cold to one of excessive heat. Now, the power of the vessels of the skin to contract is one of very great importance in regard to the regulation of the animal heat. In so-called cold-blooded animals, such as fish, amphibia, and reptiles, the temperature of the body varies with that of the surrounding medium, air or water, in which the creature lives. But in warm-blooded animals—birds and mammals—the temperature of the body remains nearly constant, whether that of the external medium be high or low. The range of temperature in which the vital functions can be carried on in warm-blooded animals is very limited; at a few degrees below the normal they completely cease, and a rise of a few degrees above will cause their permanent arrest and the speedy death of the animal. Heat is constantly generated in the body by the combustion going on in it, but its amount would be too small to maintain the proper temperature in cold countries unless there were some mechanism in the body to prevent its being readily given off from the surface. In hot countries, where the external temperature is higher than that of the body, an arrangement is requisite, on the contrary, to lessen the heat of the body. The skin is the apparatus through which the regulation is produced in both instances. When the air is cold, the vessels of the

skin contract and prevent the blood from circulating readily through it. The skin from which the blood is driven by the contraction of the vessels becomes pale and cold. When the contraction is so great as to stop the flow of blood through them entirely, a bluish colour is perceived, because the blood in the vessels has become so venous as to acquire a black colour, which, showing through the skin, gives to it a bluish or livid appearance. The skin and cellular tissue below it are bad conductors of heat; and the rest of the body is thus protected from cooling by the skin and subcutaneous tissue, in much the same way as a teapot is prevented from cooling by a cosy. The blood which circulates in these protected parts retains its high temperature, and thus the vital processes are not interfered with. In warm-blooded animals, such as porpoises or whales, the skin and cellular tissue alone would be insufficient to protect the vital organs from the external cold, for this in the case of whales in the Arctic Ocean is sometimes most intense. But in them the protective power of the skin and subcutaneous tissue is greatly increased by the deposit in the cellular tissue of an enormous layer of fat, which is a very bad conductor. Were it not for this, the cold, passing through the skin, would quickly chill the muscles, so that they would no longer respond to the impulses of the will. This effect was seen in the champion swimmer Johnson, who attempted to cross the Channel, but who had to be lifted into the boat perfectly powerless and unable to raise a limb before he had advanced many miles. The same thing would almost certainly have happened to Captain Webb had he not, in addition to the oil which he rubbed on his skin externally, possessed a fair amount of subcutaneous fat, which protected his muscles from the chilling effect of the external cold.

So long as the vessels of the skin, subcutaneous tissue and its fat, are contracted, the loss of heat from the surface of the body is to a great extent prevented. But when the cutaneous vessels dilate, the warm blood from the interior rushes freely through them, the skin itself becomes very warm, and if the external air be cold this warmth is rapidly abstracted. When the air is very dry its conducting power is small, and so it does not chill the skin much, excepting when in motion. Consequently the skin can be exposed to air 50° below zero without a feeling of great discomfort if the air be perfectly still; but if the air be in motion, heat is rapidly abstracted at this low temperature. If the air be moist it conducts away heat much more rapidly, and excessive cold may

be felt when the thermometer indicates only a few degrees below the freezing-point.

When the air is hot the vessels of the skin dilate and the blood flows freely through them. If the external temperature be higher than that of the body, as it is in the Tropics, this arrangement would tend, instead of lowering, to raise the animal heat, and thus to cause death; but this effect is prevented by the occurrence of sweating. Under the influence of heat the sweat glands pour forth an abundant secretion by which the skin is kept constantly moist, and abundant evaporation takes place. Now, the quantity of heat required to produce evaporation is very great, the heat being converted in the process into the mechanical work of changing the water from a liquid into a gaseous form. It takes five and a half times as much heat to convert boiling water into steam as it does to raise the water from the temperature of freezing to that of boiling. The immense loss of heat by the evaporation of perspiration thus keeps the bodily temperature normal, even when the external heat is excessive. In negroes the evaporation cools down the skin so much that it has been observed on the West Coast of Africa that when in health their skin is as cold as marble while streaming with perspiration, and that heat of the skin is in them always a sign of fever.[1] Sir Charles Blagden[2] also found that in a room the air of which had a temperature of 198° Fahr., his side felt cold like a corpse to the touch.

The skin is thus one of the great regulators of temperature. To recapitulate shortly: external cold makes its vessels contract, and confines the warm blood to the interior of the body; external heat makes its vessels dilate and the sweat glands act, and thus the body is cooled by evaporation. The sensation of heat and cold is chiefly perceived in the skin, and our subjective sensations are regulated by its temperature rather than by those of other organs. We may now understand how it is that in cold climates men take alcohol to make them warm, and in hot climates to cool them. The effect of alcohol is to cause dilatation of the vessels of the skin and thus to allow the warm blood from the interior of the body to circulate freely over the surface. The consequence of this is a pleasant glow of warmth. This dilatation of course allows opportunity for more rapid loss of heat, but if the external temperature is not very low this loss may be of no very great importance, and

[1] S. Billing, *Journal of Science*, October 1882, p. 620.

[2] Brewster's *Letters on Natural Magic*.

the individual may enjoy a temporary pleasure without any bad effects. But in extreme cold, as for example in the Arctic regions or even in this country if the exposure is to be prolonged, the case will be very different. Sir Joseph Fayrer tells me that on one occasion while deer-stalking he offered the keeper some spirits from his flask, but his offer was refused on the ground that the day was too cold. Previous experience had shown the keeper that although the temporary effect might be pleasant, the after effects during prolonged exposure were disagreeable.

The experience of the lumberers in the forests of Canada has taught them the same thing. During the intense cold of a Canadian winter these men are engaged in felling trees, which are afterwards dragged over the snow to the nearest river. They are then made into rafts and floated down the current to the large towns in the ensuing spring. These men are fond of spirits, and when they reach the towns in spring generally give way to intoxication; but during the winter they are strict abstainers. They know the danger of indulgence, and knowing also the strength of temptation they refuse to have spirits in the camp; and if a keg of whisky happens to find its way there they will deliberately destroy it, lest they should be led, in spite of their resolution, to indulge in the luxury to their own injury. Dr. Milner Fothergill tells me that a party of Americans crossing the Sierra Nevada encamped in an exposed place above the snow-line before going to sleep. At night some of them took no spirits at all, and they lay down cold and miserable; some of them took a moderate quantity, which slightly warmed and cheered them for the time; some of them took a large quantity, and they lay down feeling very warm. But next morning those who had taken no spirits got up quite well,·those who had taken a little rose cold and wretched, while those who had taken a large quantity slept the sleep of death. In those who had not interfered with the healthy regulation of their temperature by taking alcohol the skin was chilled, but the temperature of the heart and vital organs was maintained, and beyond temporary discomfort they received no harm from the exposure. Those who took a small quantity of spirits, and thus dilated their cutaneous vessels in spite of the external cold, warmed their skin and felt comfortable; but it was at the expense of the general body-heat, and so they paid by subsequent discomfort for their temporary pleasure. Those who had taken a large quantity continued to warm the surface for some hours at the expense of their vital

organs. At each round the blood returned to the heart colder and colder, until the pulses ceased and the unfortunate people were frozen to death. The experience of all Arctic travellers tells the same story—that indulgence in alcohol is almost certain death when the external cold is great.

Under certain circumstances, however, alcohol is useful in counteracting the effects of exposure. The expulsion of the blood from the vessels of the skin by exposure to cold increases the quantity in the interior of the body, and may occasionally tend to produce congestion, or lead to inflammation of internal organs. For example: a lady was travelling in Scotland one cold day on the outside of a coach, and, as the surface became colder and colder from exposure, she began to suffer internal pain. Her husband wisely gave her a glass of brandy, which at once removed the pain. Here the danger was from internal congestion, and this had to be balanced against the effect of exposure. But although, from the atmospheric conditions which have already been alluded to, the subjective feeling of cold was considerable, the external temperature was not extremely low, and the surface was protected by warm clothing; the chief danger here lay not in too rapid a loss of heat from the surface, but from the occurrence of internal congestion, and therefore, as the successful result proved, the use of alcohol was right and proper. Also, after the exposure to cold is over, the cutaneous vessels are sometimes long in relaxing, even after the person has come into a warm room. The consequence of this is that the external warmth has little effect upon the general temperature of the body, or even upon the deeper layers of the skin, and thus the person cowers, cold and shivering, over the fire, or turns round and round in front of it, in the vain attempt to warm himself. If a glass of spirits be now swallowed, and especially if it be mixed with hot water, it rapidly causes the vessels of the skin to dilate, the blood circulating over the surface is warmed by the external heat, it returns warm from the skin to the heart, and soon a comfortable glow succeeds the previous chill. Not only is comfort thus afforded, but the distribution of the blood being once more equalised between the surface and the interior, the danger of internal congestion is diminished. In many cases simple hot water and sugar, flavoured with a little ginger or lemon, a cup of warm milk or tea, or of coffee is sufficient to produce a similar effect; but their action is not quite so strong as that of hot water and spirits, inasmuch as the alcohol has a

special power of dilating cutaneous vessels apart from the hot water with which it may be mixed. While, therefore, the other warm drinks are useful in slighter cases of chill, spirits and water are more likely to be efficacious when the chill is severe.

In hot climates the effect of spirits is to dilate the cutaneous vessels in the way just mentioned, and the flow of blood to the surface being accompanied by increased secretion of the sweat glands, the loss of heat by evaporation is augmented, and thus the person feels cooler instead of hotter.

We must now consider the effect of alcohol on other parts of the nervous system than those which regulate the vessels. One of the first effects is, as we have said, dilatation of the vessels and acceleration of the circulation. The increased supply of blood to the brain and spinal cord may augment their functional activity, rendering thought more easy and action more ready, without any alteration in the character or precision of either. But when the quantity of alcohol is larger the nerve centres of thought and action are themselves affected by it. It is possible that the function of the various parts of the brain is somewhat increased by the direct action of the alcohol upon them when it is carried to them by the blood, and that this increase is apart from the greater supply of blood which they obtain from the freer circulation ; but such an increase, if it exists at all, is in all probability both slight and temporary, and is succeeded by weakened power, and finally by paralysis. To the increased mental and physical power, due to the quickened circulation, succeeds a stage which one might at first sight believe to be one of increased power, but which a more careful examination will show to be one of diminished mental power. To the stimulant action succeeds the narcotic, although it is difficult to draw an exact line of demarcation between the two. The action of a narcotic is to lessen the closeness of the relationship between the organism and its environment, and the delicacy of its power of adjustment to external circumstances. In consequence of this we see the restraints which the individual usually puts upon himself, out of consideration for his surroundings, gradually disappear, and the faculties of his mind thus let loose are like a fly-wheel from which a break has been removed. The individual figures more largely to himself; he becomes more and his surroundings become less important to him. His tongue runs more freely, his imagination becomes more lively, and ideas seem to succeed one another with increased rapidity. His emotions

become more easily excited, and manifest themselves more plainly than usual, as sympathy, affection, or pugnacity. All those appearances of increased mental power may be explained, and probably correctly, on the supposition that the highest faculty of all—viz. the power of self-restraint—is weakened by alcohol.

The old proverb, *in vino veritas*, shows that under the influence of wine men forget their caution, and their power of self-restraint being impaired, they let out the secrets which they ought carefully to have preserved. From one faculty to another the paralysis gradually proceeds, and the order in which this takes place, although it varies to a certain extent with the individual, and also with the variety of alcoholic drink employed, may generally be said to be in the inverse order of their development. The new-born infant has but few of the powers possessed in manhood; its heart beats and its lungs breathe, and it can make irregular movements; but it has no power of receiving exact impressions, or of using its limbs for definite intended acts. The more complicated the actions which the different parts of the body have to perform the longer are they in being acquired, and the child is first able to move its body, which in adult life performs no complicated actions; afterwards its arms; and lastly the fingers, which finally acquire great delicacy and precision of movement. This is well expressed by Tennyson in the *Princess*, where he describes the movements of a child lying on the ground and seeing its mother approach. Moved with delight it began

> "A blind and babbling laughter, and to dance
> Its body, and reach its fatling innocent arms
> And lazy lingering fingers."

Its excitement, as Herbert Spencer puts it, flooded along the nerve channels which afforded the easiest passage, and while at that early age the nerves connected with the body were already complete, the nerve centres for the fingers were still undeveloped. In some people, even up to old age the nerve centres go on growing, for some persons are able even in old age not only to acquire new ideas, but new expressions, new languages, and even new and unaccustomed movements of the fingers. Now, these acquirements are the external indications of alterations and of new development going on in the nerve centres. It is only in very exceptional instances that we find this power retained in old age; in most people it is very much diminished after middle

age, and is most active in childhood and youth. We see that it is usually very difficult for any one to acquire in later life those complex movements of the fingers, for example, which are required to play the violin, the nerve centres being then little capable of undergoing the necessary modifications which would have occurred comparatively easily in youth. It is not only the nerve centres which are most readily modified in early age, the whole being is more easily acted on by external influences until after a certain time, when the face and figure acquire a definite character, or become, as it is usually termed, "set." In watching the development of faculties in children, we see that one of the first powers acquired is that of laughter. They learn to understand the meaning of words before they can speak. Some children learn to speak before they can walk; others, again, walk before they can speak. But in all of them the powers of wise consideration and of self-restraint are of late development, and these, as we have seen, are among the first to be affected by alcohol, which thus tends to reduce the adult more and more to the state of a child. The nervous channels which have been, so to speak, graven by education become one by one obliterated in the order of their development, and the nervous energy, which ought to have been distributed over them all, runs only through the older and simpler channels. Self-restraint and consideration being lessened, or destroyed, fancy is set free and expression is unchecked, so that we see in adults under the influence of alcohol the same fertile imagination and easy chatter that we get in the child. We notice also the same tendency to ready excitement and display of the emotions: to laugh, to cry, to sing, to fight. In some children the power of speech is long in being acquired, and they are unable to express their ideas and feelings in words, although it is quite evident from their actions that their mental faculties are in no way deficient. Others, again, acquire the power of speech very soon. Just as we find differences in the readiness with which speech is acquired, so we find differences in the rapidity with which it is lost under the action of alcohol. In some people the power of expression is diminished before the mental faculties are much affected, and the earliest indication that they have taken more alcohol than is good for them is afforded by the difficulty of articulation. In others, again, this difficulty does not set in until the ideas are so confused as to be unworthy of expression.

In children we notice differences in the comparative readiness with which the powers of walking and of speech are acquired, and this also can be observed under the action of alcohol. Some people appear perfectly sober as long as they are sitting, but when they arise they are unable to walk steadily. Others, again, are able to walk perfectly well when they are so stupid as not to know what they are about.

This is usually expressed by saying that "one man gets drunk in his head, and another in his legs." This phrase expresses the condition distinctly enough, but it is not quite correct, inasmuch as the two greatest nerve centres which alcohol affects are both situated in the head—viz. the cerebrum, which is the organ of thought, and the cerebellum, the nerve centre which co-ordinates the movements of the different muscles, or, in other words, makes them act harmoniously together so as to produce the movements required to maintain the balance of the body, either in standing or walking.

The loss of co-ordination which first affects the muscles of the tongue or of the legs extends from them to others. Those of the eye no longer act together, and so double vision is produced. Indeed, the staggering of a drunken man is probably due for the most part to erroneous conceptions of the position of surrounding objects. He generally seems to have the idea that he himself is perfectly steady, and that all his troubles are due to the movement of the ground on which he is standing, or the houses, trees, railings, and lamp-post near which he happens to be. But even after the power of co-ordinate voluntary movement is gone, we find that reflex action will still continue in the spinal cord, and it appears to be in consequence of this that a man is able to ride when he cannot walk. When something is put into one's hands the fingers have a tendency to close upon it unconsciously, the impression made upon the skin passing up the sensory nerves to the spinal cord and down again through the motor nerves to the muscles, while the brain has little, if anything, to do with it. So when a drunken man is put upon a horse, the impression made upon the skin of his thighs by the pressure against the saddle is transmitted up to the spinal cord, and reflexly down the motor nerves to the muscles of the legs. This motor impulse causes the muscles to contract so as to retain him in his seat, although the upper part of his body may be swaying helplessly about. It has been noticed that drunkards in this condition enjoy a remarkable immunity from the consequences of injuries. One sometimes sees

a drunken man pitched violently from a horse, and when the bystanders rush to the spot, expecting to find him dead, they are astonished to discover that he has been little injured. In his *Scrambles among the High Alps*, Leslie Stephen tells the story of a guide who, while drunk, fell over a precipice so deep that a fall over it seemed almost certain death, and who yet sustained little injury. Stephen accordingly gives his readers the advice either not to fall over a precipice or to get thoroughly drunk before doing so. I myself once saw a man who had thrown himself while drunk over the Dean Bridge in Edinburgh, a height of about 200 feet, on to the rocky bed of the stream below. A sober man would probably have been instantly killed, but this individual, though he had broken both of his thigh-bones, quickly recovered; and I saw him a few weeks afterwards hopping briskly about on crutches, the legs being nearly, though not entirely well.

The reason of this immunity probably is that the nerve centres which regulate the heart and vessels are so much paralysed in the drunken man as not to be affected by the shock of the fall, which in a sober man would have acted on them so violently as to stop the heart, arrest the circulation, and cause instant death.

The alcohol which is circulating in the blood in this condition is partially burnt off, but a good deal of it is removed from the body by the kidneys, although little or none is excreted by them when small quantities only of alcohol have been taken. When the excess has not been too great the patient gradually recovers his powers as the alcohol is eliminated, and fortunately in man we do not often meet with cases of absolute poisoning by a single indulgence in alcoholic liquors. By giving it to animals we are able to see its further effect, and we find that in them the nerves which keep up the respiratory movement become paralysed, the heart itself becomes feebler and feebler, both respiration and circulation stops, and the animal dies. We see, then, that with the exception of the primary stimulation caused by its effect on the circulation—and possibly to a very slight extent indeed, if at all, on the nerve centres themselves—the action of alcohol is one of progressive paralysis, affecting the highest powers of the mind first, and reducing the man first to the condition of a child, and afterwards not only to, but even below that of a beast. Even if it should not actually poison the individual and kill him at the time, the consequences which ensue from excess are by no means agreeable; the individual gradually recovers his powers

as the alcohol is eliminated, but he does not, as a rule, recover his health and comfort at once; his salivary glands do not secrete, his mouth is dry and his tongue foul, while his stomach is even more deeply affected. This was well seen by Dr. Beaumont in the case of Alexis St. Martin, the Canadian huntsman, to whom reference has already been made. The inner coat of the stomach, which in its natural and healthy state was of a light or pale pink colour, and of a soft, velvet-like appearance, on the day after intoxication was of a darker red than natural, dry, irritable, and its mucous coat abraded in spots. This condition is usually accompanied with loss of appetite and thirst, and the disordered condition of the nerve centres leaves behind an intense headache, which should act as a warning against a repetition of the indulgence. If this warning is not taken, and spirits are drunk again and again, we find that the symptoms of apparent disturbance pass away; the person may feel quite well, the nausea is gone, thirst may be absent and the appetite may be good; to all external appearance the continued use of spirits has done away with the evil effects of the primary indulgence; but this is not the case. Dr. Beaumont mentions that after St. Martin had been drinking spirits pretty freely for eight or ten days he complained of no pain, showed no symptoms of general indisposition, said that he felt well and had a good appetite; but on looking into the stomach the condition was very far from being healthy; its mucous membrane was morbidly red and congested; there were small white patches of aphthæ on the surface, and the secretions were vitiated; the surface was tender, and blood seemed to exude from the congested parts. Even when the stomach became still worse, with more extensive congestion, with livid spots on the surface from which small drops of grumous blood exuded, larger and more numerous aphthous patches, and the gastric juice so mixed with thick ropy mucous and ropy purulent matter slightly tinged with blood as to resemble the discharge from the bowels in chronic dysentery, St. Martin complained of hardly any symptoms; all that was noticeable was a slight uneasiness and tenderness at the pit of the stomach; some giddiness, dimness, and yellowness of vision on stooping and rising; a thin, yellowish-brown coat on the tongue, and rather a sallow appearance of the countenance; his pulse remained uniform; he rested normally, slept well, and had a good appetite. A large quantity of alcohol, as we have seen, prevents the body from being affected by

shock, and continuous indulgence seems also to rob the body of the power of perceiving the injury which the alcohol is inflicting upon the stomach and other parts of the organism. The warnings of danger which pain ought to give are no longer perceived, and the individual pursues his deluded course in fancied safety. This condition is well described in Proverbs, where the writer warns those who indulge in wine in the following words: "Yea, thou shalt be as he that lieth down in the midst of the sea, or as he that lieth upon the top of a mast. They have stricken me, shalt thou say, and I was not sick; they have beaten me, and I felt it not. When shall I awake? I will seek it yet again."[1] Unconscious, then, of his danger, a man may go on indulging in great excess; but if this is carried on continually beyond a certain point, the usual consequences are that the appetite fails, food is refused, the nutrition of the nervous system suffers, and delirium tremens results. When in charge of a hospital ward intended for the reception of such cases, I found the usual history to be that four days before the outbreak of the attack the appetite failed, and either food was not taken at all or was at once rejected. Obstinate vomiting is frequently a marked symptom in this disease, forming an obstacle to the patient's recovery, and sometimes leading to exhaustion and death. The muscles become tremulous, this tremor being readily remarked in the tongue when it is protruded. The patient is restless and sleeps badly, and is disturbed by unpleasant dreams; then in place of dreams occurring only during sleep, he becomes plagued by hallucinations when awake. At first these occur especially at night, but afterwards continue during the day; they are nearly always of a disagreeable kind, and are sometimes perfectly fearful. They not unfrequently take the form of insects or animals, which are crawling around or over him; or he sees strange persons or devils, who haunt the room, hiding in corners, concealing themselves behind the curtains of his bed, or gibbering and mocking him, pulling at him, or tormenting him. He lives in a state of terror, and requires to be carefully watched lest in his attempts to escape from some fancied tormentor—man, animal, or devil—he should destroy himself by throwing himself out of the window if confined to his room, or over a bridge if he should be walking outside. This condition, after lasting for three or four days, passes off, the patient falling asleep and awaking convalescent. But sometimes, especially

[1] Proverbs xxiii. 34, 35.

in those who have already suffered from repeated attacks, a fatal result ensues, the indivdual falling into a condition of stupor from which he cannot be awakened, and which gradually increases until death ensues. In other cases the patient becomes worn-out and death ensues from weakness; sometimes, also, the patients die suddenly without any apparent cause.

When excessive indulgence in alcohol is frequently repeated, death may ensue from delirium tremens as just described; but even when the excess is not so great as to lead to this result, the organisation becomes gradually deteriorated. This deterioration may occur in men who have never shown symptoms of intoxication —who have drunk much, but may never have been drunk in their lives. The organs chiefly affected are the nervous system, the stomach, the liver, and the kidneys; other parts of the body, however, are not exempt, and the countenance and complexion very often betray the alcoholic habit. The impairment of combustion which alcohol produces in the tissues leads to the accumulation of fat, and even to the conversion of the muscular tissues into fat; the skin acquires a satiny feeling; the capillaries of the face, and especially of the nose, become permanently dilated, giving to it a rubicund appearance; the features lose their sharpness of outline, and the aspect becomes bloated. The stomach suffers in the way which has already been mentioned; a state of chronic inflammation is induced, the tongue becomes furred, the breath offensive, the appetite is lost, and there is vomiting—especially in the mornings. Inability to eat breakfast, nausea, and vomiting after rising in the morning, are often indicative of alcoholism, although they may proceed from other diseases quite unconnected with it. Just as we saw that individuality altered the order in which alcohol affected the different parts of the nervous system during the process of intoxication, so we find that the order in which different parts of the body suffer in chronic alcoholism varies with the individual; in some the stomach suffers, in others the liver, in others the kidneys, and in others, again, the nervous system is most easily and seriously affected. Everything that is taken into the stomach and absorbed from it by the blood must needs pass through the liver before it can get into the general blood stream by which it is to reach the brain and kidneys. We naturally expect that the liver would be likely to suffer from any irritant taken into the stomach and readily absorbed like alcohol, and this is the case. From the effect of the alcohol the liver is apt to become larger and its structure loaded

with fat, while the connective tissue which holds together the secreting cells which compose the main part of its bulk also increases. By and by, the fat becomes absorbed, the connective tissue encroaches more and more on the secreting structure and also on the blood-vessels, the liver becomes small and hard, the flow of blood throughout from the stomach and intestines is impeded, fluid consequently accumulates in the abdominal cavity, and dropsy is the result. Sometimes this occurs in men whose nervous system, stomach, and kidneys appear to have suffered but little; their faculties remaining unimpaired, their appetite being good—or at least fair; and the dropsy being limited to the abdomen. In others, again, the kidneys suffer more, and then the dropsy extends to the whole body, and not unfrequently the patient dies from stupor or convulsions, due to the accumulation within the body of the waste products which his diseased kidneys are unable to eliminate. In others, again, the nervous system suffers most: the will may be impaired, and the individual become vacillating; the moral sense is diminished, and the distinction between right and wrong, between truth and falsehood, is less clearly perceived; the power of self-restraint gradually disappears, and although the individual may show great compunction for his failings, he is unable to resist temptation, and yields to it as often as it presents itself. He may appear to cherish kindly and loving feelings towards his family and neighbours, but these are chiefly subjective, and do not lead to definite action; for although he may see that he is causing them the most intense misery by his conduct, he continues his course, while he may at the same time loudly bewail its consequences; again and again he may take the pledge, and again and again he breaks it; his will has been destroyed by the poison, and he is now helpless to resist. The recoveries from a condition of confirmed drunkenness are few, but they do occur. One case—which the unfortunate sufferer has himself described—was that of the Rev. J. Vine Hall, better known as the author of a little book called *The Sinner's Friend.* His description of his condition and cure will well repay perusal.

The Causes of Intemperance

The causes which lead to intemperance are various, although, as we have said, the reason why men drink is to obtain pleasure or to

avoid pain. Some drink in order to stupefy themselves, and thus destroy the effect of surrounding external circumstances. Thus we find the advice given in the Book of Proverbs: "Give strong drink unto him that is ready to perish; and wine unto those that be of heavy hearts: let him drink and forget his poverty, and remember his misery no more." The effect of alcohol, no doubt, is to give the individual temporary pleasure and forgetfulness of sorrow; but it is a pleasure dearly purchased, as in most cases it simply increases the misery afterwards, and hurries him along the road to ruin. The taste for alcohol may sometimes be acquired by its being at first taken not to obtain temporary relief from great sorrow and misery, but simply to counteract the effect of petty worry or irritation. One of the circumstances which may tend to lead to this is bad cookery. A savoury meal is much more digestible than an unsavoury one. We have already seen that while gentle stimulation of the stomach aids digestion very much, over-irritation arrests digestion and produces vomiting. Now, the stomach can be affected not only by substances introduced into it, but also by mental conditions. It is well known that bad news destroys the appetite; and grief or disappointed love causes more or less rapid emaciation, and may reduce the strength of the person so much as to render him liable to attacks of some diseases—for example, such as consumption. A disgusting odour will not only destroy the appetite, but cause nausea and vomiting; and on some persons of a highly nervous temperament badly-cooked food has a similar action. Sometimes, too, if a meal, though good in itself, is limited simply to meat and potatoes, a feeling not of hunger, but a want of something else is perceived after it is over; this feeling is not caused by insufficiency of food, but is rather a craving for something to stimulate the digestive secretions. The chief reason why savoury and well-cooked food is more digestible than unsavoury food is that its pleasant smell and taste excite the digestive secretions. This is popularly expressed by saying that something nice "is enough to make one's mouth water." The free secretion of saliva causes the starchy parts of our food to be quickly digested, both in the mouth and stomach; but this is not all. When it reaches the stomach it stimulates the secretion of gastric juice, and the gastric juice, when it passes out of the stomach, stimulates the secretions in the intestines below. Thus, by the introduction of the savoury food, the digestive secretions of the intestinal canal are stimulated one after another; digestion occurs rapidly, and the

strength of the body is amply maintained. Badly-cooked and disagreeable food, on the contrary, even if it does not cause nausea, has no such stimulating effect on the secretions: the process of digestion proceeds slowly, and time may be allowed for abnormal fermentation of the food to take place, with the result of producing acidity, flatulence, and intestinal disturbance. It is very unfortunate that the wives of many artisans know little or nothing of cookery, and although the food which they use may be expensive and good in itself, the dishes they serve up to their husbands are by no means appetising. When, in addition to this, it happens to be washing-day, and the odour of soap-suds pervades the house, when children, disturbed in their play, are crying around the room, and the wife herself, tired and worried, is perhaps not in the best of tempers, the conditions for a man's digestion are very far from being favourable. It is no wonder, then, if he should go out and try and get a meal at a public-house, or, at any rate, should try to lessen the effect of the worry by a glass of spirits at the nearest tap. Even when the meal is ample in itself, a sense of want is sometimes felt, if it consists of only meat with potatoes or bread, and a craving is felt for something savoury or stimulating. This craving for stimulants is removed by a glass of beer or of wine, but the same effect is also produced by other savoury substances containing no alcohol. All that is wanted seems to be a stimulus to the secretions, and a little salt put upon the tongue will effect the purpose; still better, perhaps, is dried fruit, a few raisins or a fig, a sweet pudding, or a piece of good cheese—all have a similar action. It is not without reason that people have fallen into the plan of taking puddings or stewed fruits at the end of dinner, and finishing up with cheese or dessert.

It is by no means necessary to have all of these, but one or other is certainly of advantage in aiding digestion. When the meal is very large we find that people are accustomed to give a still further stimulus to their digestive powers by taking a small glass of brandy or curaçoa at its termination; but the wise man will not overload his stomach so much as to require the alcoholic stimulant to aid his digestion; and the remedy for its requirement in the artisan is a better diffusion of a knowledge of cookery, and the use of puddings, stewed fruits (such as American tinned peaches and apricots), raisins, figs, or cheese to conclude a meal.

In atonic dyspepsia, where the digestion is slow and feeble, as in persons debilitated by town life and overwork, a little brandy or

whisky-and-water, wine or beer, may be necessary or advisable at meals; but it is of very great importance that, where this is prescribed by a medical man, he should say definitely how much wine or spirits he intends the patient to take, and for how long a time it is to be continued. For his own sake it is advisable that he should write it down and even keep a copy of it, for it frequently happens that patients who have a liking for alcohol shelter themselves from the remonstrances of friends by saying that they are taking it by the doctor's orders. The medical attendant thinks perhaps that they are taking a single glass of sherry at dinner, while they are taking it not merely with meals, but between meals to the extent perhaps of a bottle of sherry a day. Nor is it always sufficient for a medical man to limit exactly the quantity of alcohol to be taken by the patient, because under one pretext or another this may be exceeded. A good instance of this is the story of the old Scotch farmer who was ordered by his doctor to take two fluid ounces of whisky in the course of the day. This would seem precise enough, but unluckily a fluid ounce consists of eight fluid drachms, and the word drachm has two meanings. To the apothecary, a dram or drachm means the one-eighth part of a fluid ounce, or about a teaspoonful; but a dram to the ordinary Scotchman is equivalent to a nip, which may be a full glass. The farmer, not knowing what a fluid ounce was, waited until his son came home from school, and on learning that it contained eight drams, was greatly delighted, and said that the doctor understood his case. He had always had eight drams a day, and he always wanted eight more. The consequence was that, instead of reducing the allowance of spirit from eight glasses, each holding about two ounces, to one glass, this unlucky prescription increased it to sixteen.

The necessity for limitation as to time is shown by the case of a lady whose friends thought she took more stimulant than was good for her, but she protested that she was taking it under medical advice. To strengthen her position, she told them that she had the prescription; but when her friends, who were still incredulous, asked to see it, they found it was twenty years old. On their asking the lady whether she still continued to take the other remedies the prescription contained, her patience gave way, and she cried, "Do you think I am a fool?"

The greatest quantity of alcohol which a healthy man can take in twenty-four hours without injury has been estimated by Parkes, our highest authority on this subject, at two fluid ounces, or rather

less than an ordinary sherry-glassful. This corresponds to about four glasses of port, or five glasses of sherry, madeira, or marsala, or from half a bottle to a bottle of claret, burgundy, hock, moselle, or Hungarian wine. It must be remembered that this is the extreme limit, and that it by no means follows that because a man may take this quantity without being the worse, he will be the better for taking it.

The question is sure to arise, whether it is advisable to cut off alcoholic liquors entirely from persons who have been accustomed to take them freely, and who are at length beginning to suffer from the degeneration caused by them. The opinion which my own observations have led me to form on this point is, that if the degenerative processes have not gone far, and there seems reason to believe that the organs, though beginning to suffer, are still fairly healthy, it may be advisable to cut off stimulants altogether. But this is not the case where the degeneration has gone far. When symptoms of dropsy appear, or where the heart is becoming feeble, or the nervous system markedly degenerated, in persons who have been accustomed to take alcohol for a long series of years, the sudden and complete withdrawal of what is to them, not only a stimulus, but is, from long habit, to a great extent, a food, is likely to be injurious. If they have indulged in it to a great excess, let it be diminished, but not entirely withdrawn.

As we have seen, alcohol diminishes the power of appreciating the relationships of the organism to external conditions, and it thus enables people to get temporary relief from the depression which unfortunate circumstances produce. Poverty and want, shame and misery, render life unendurable to some unfortunates, and their only resource is drink. In some the shame and misery are so great as to be unbearable, and they are sometimes rendered greater by remorse, and by a comparison of present degradation with a respected and happy former life, even although the organism is not depressed by hunger or cold. In others, cold and want increase still further the depression produced by other miserable surroundings; and even in the case of the artisan, of whom we have spoken, unsatisfied appetite intensifies the disturbing effect of small worries. All these conditions tend to create a desire for alcohol, for, as we have already mentioned, alcohol not only lessens the power of the organism to perceive the condition of external circumstances, but the condition of internal organs. Thus in Alexis St. Martin the greatly deranged condition of the stomach, which

after a single indulgence in alcohol would probably have caused loss of appetite and headache, was not perceived after eight or ten days' indulgence, and he felt perfectly well, although he was really ill. Pleasure and pain, happiness and misery, are not entities; they depend upon the relation of the organism to surrounding circumstances: thus we see one person eating with appetite what another would turn away from in disgust, and a child in the gutter amusing itself in great delight with a few stones and twigs, which in imagination it builds into palaces and peoples with princes, while a child of wealthy parents is fretting and disgusted amid the most costly toys. This is to be seen still better, perhaps, when mental disease has completely destroyed the normal relations between the body and the surroundings. The maniac who thrusts his fingers into the fire, laughs delightedly when he sees them blazing (as we have already mentioned), when a sane person would shriek with terror and pain; another maniac fancies himself possessed of enormous strength and boundless riches, when he is hardly able to stagger along and has not a penny to call his own, and may think himself emperor of the world and even Almighty Ruler of the universe, when he is actually confined in a lunatic asylum, and every action is controlled by his keepers. In others, again, an entirely opposite condition occurs, and a man of enormous wealth fancies himself unable to afford even the necessaries of life, and is in constant terror that he will die in a workhouse. And there are not a few people perfectly sane and free from all delusions, who yet suffer from melancholy which they cannot throw off, and yet for which they can assign no reason. They ought to be happy, for they are successful in life; they have no pressing cares; their homes are comfortable, and they are surrounded by loving friends; and yet, in spite of all, they feel low, melancholy and miserable. Here the condition of depression is obviously in the organism and not in its surroundings. In the case of the wealthy man afraid of the workhouse, this condition may be due to some alteration of the brain which is permanent and cannot be removed; but in others who suffer simply from depression of spirits, the condition is only temporary, for it varies from day to day, and will sometimes disappear entirely. Slight variations in it are probably caused by the effect of the weather upon the body, but the entire disappearance of the melancholy not unfrequently occurs during a holiday, when the person gets plain food and plenty of open-air exercise.

The healthy condition induced by such food and exercise may continue for some months after the holiday is over, and then the person begins again to suffer from the depression which is to him or to her quite unaccountable. We have already seen that the cause of it is something within the sufferer's body, and something, moreover, which is of a temporary nature. In many cases it is really due to poisoning by substances formed within the body, or diffused through the air of his house; in other words, he is poisoned by the products of imperfect digestion, or by sewer gas, arsenical wall-papers, or by a mixture of all three. We have had occasion to refer several times to the effect produced upon the circulation, and through it on the general nutrition, well-being, and happiness of the individual by food, or by a small dose of alcohol taken into the stomach and acting reflexly through it on the heart and vessels; thus moderate stimuli to the stomach produce a feeling of well-being, but excessive stimuli arrest gastric secretion and lead to nausea or vomiting. How exceedingly miserable nausea makes one is known to everybody, and no external circumstances, however favourable, can render a person happy while suffering from sea-sickness. The condition of the abdominal organs is thus closely connected with feelings of joy or depression; nor is this to be wondered at, for the same nerve which regulates the movements of the heart sends branches also to almost every one of the abdominal viscera. When the stomach is in a state of slight chronic irritation or catarrh, a feeling of depression and despondency is often felt. But the people whose case we are now discussing are often extremely careful in their diet, and their digestion of such food as they take seems perfect, so that we must look to another organ for an explanation. This organ is the liver; and the Greeks showed much wisdom in connecting with the disorder of its function the depression of spirits, to which they gave the name of black bile, or melancholy (μελαν, black; χολη, bile). All the blood from the stomach and intestines must necessarily pass through the liver before it can again get into the general circulation, and if the portal vein, or the vein through which this blood reaches the liver, be obstructed in an animal it will die very speedily, almost as quickly indeed as if it had been bled to death by opening a large vessel. Thus does a slight interference with the flow of blood through the liver derange the circulation in the stomach and intestines, and a great obstruction profoundly affect the systemic circulation. But this is not all—most of the

products of digestion are absorbed from the stomach and intestines by the blood-vessels, and these products must also pass through the liver before they can reach the heart, brain, and muscles; and well it is that they must do so, for the limits of existence in relation to digestion as well as to animal heat are very narrow. Food and poison are much more closely connected than we would at first imagine, and it has been lately found that in the process of digestion food is actually converted into substances which in large quantity act as poisons; butcher's meat, fish, eggs, and albuminous matters generally are converted in the process of digestion into soluble substances called peptones. These peptones, when introduced in large quantity directly into the veins, have the power of completely destroying the coagulability of the blood—at least in dogs; and they greatly depress the circulation, so that the tension of the blood in the vessels becomes much diminished. When the quantity injected is large they completely arrest the secretion of the kidneys, and produce convulsions and death. It almost seems a wonder that we are alive at all, when we consider that if our nutritive processes were insufficient to maintain our temperature, so that it sunk only a few degrees, we should die of cold: if it rose a few degrees, we should die of fever heat; and that at almost every meal we are forming enough poison to kill us if it were only poured all at once into our blood; but fortunately the mechanism of the animal body, although very delicate, is very precise, and though it works within narrow limits, it works within them well.

The peptones formed by the digestion of albuminous food apparently undergo some change in the blood, even in the short interval that intervenes between the intestines and the liver; they have almost entirely disappeared by the time they reach it, and probably their conversion into some other substance, nutritive and not poisonous, ought to be complete before they pass through the liver. Sometimes, however, we know that this is not the case, inasmuch as the peptones are actually excreted from the body by the kidneys. Their passage into the general circulation from functional inactivity of the liver may be regarded with much probability as one of the causes of depression and melancholy: such is probably the case with those people who suffer from nervous depression, weakness, and melancholy, chiefly during digestion, and especially during that period of it when the absorption of the peptones is taking place, that is, about two or three hours after a meal; thus, having breakfast between eight and nine they begin to

feel weak and miserable about eleven, and having had luncheon between one and two they are attacked by another feeling of weakness about four. To relieve this condition they not unfrequently think it necessary to take a glass of wine and a biscuit, or a nip of brandy; perhaps, instead of this, they may take some strong beef-tea, and try to keep up the strength by forcing themselves to eat meat three times a day; but this mode of procedure brings no relief. The warm beef-tea, the glass of wine, or the nip of brandy produce a momentary stimulation, and give temporary relief, but the depression soon returns, and these temporary remedies only tend to interfere with its ultimate cure.

A fire may go out from two causes: either because it wants fuel, or because it is choked with ashes; and the fire of life may suffer in a similar way. Some of the poverty-stricken seamstresses in the east of London suffer from depression because they have insufficient food: a little bread with perhaps a scrape of butter—meat being a luxury which is not to be thought of—from week's end to week's end. In them there is depression from lack of food; but in many who are well off, and have but little to do, the nervous depression is even greater, and the vital flame sinks not from lack of fuel, but from accumulation of ash. They think their weakness proceeds from want of food, and they force themselves to eat, and especially to eat animal food, whereas what they want is abstinence and exercise. To tell one of the poor seamstresses, already mentioned, to fast once or twice in the week would be an absurdity, for her whole life is one continual fast; but there are not a few to whom an occasional fast would be a benefit, both physical and moral. More people in this country shorten their lives by over-eating than by starvation; and an unnecessary excess of animal food not only leads to physical disorders, but to an irritable and irascible frame of mind. Instead of trying to remove the depression between eleven and four by taking a glass of wine or spirits, a much better plan is to sip a glass of water, or soda-water, and eat a biscuit. If a greater stimulus than this is needed, a glass of hot *eau sucrée*, with a lemon squeezed into it, may be taken. It is not a matter of indifference whether the water be drunk down at a draught or sipped, for the act of sipping has a very extraordinary effect upon the circulation, as my friend, Professor Kronecker, has shown: during the act of swallowing, the power of the restraining nerves upon the heart seems to disappear; and if any one will count their pulse before they take a sip of

water, and while they are taking it, they will find that while they are swallowing the pulse becomes nearly twice as quick as before. It has long been known that by sucking ale through a straw a person becomes drunk much more quickly than when the same quantity is taken at a single draught; and it is probable that this alteration in the circulation by the process of suction has much to do with this curious result.

But in order to obtain a permanent cure a patient must try and get exercise, so as to put the liver into proper condition. The bile which this enormous gland produces is secreted under very low pressure, and a very slight obstruction indeed is sufficient to prevent its exit from the bile duct into the intestine. Its expulsion is usually aided by mechanical compression, because the liver lies directly under the diaphragm; and during exercise it is compressed between this muscle on the one side and the abdominal viscera on the other; these are pressed up against it by the muscles of the abdominal walls. But this exercise, in order to be efficacious, requires to be brisk. When a person is sitting at rest, or even walking slowly along a level road, the abdominal muscles yield as the diaphragm descends, and so little or no compression is exerted on the liver. In running, in climbing, in jumping, in vigorous efforts of any kind, the conditions are different; the abdominal muscles and diaphragm are frequently brought into action at the same time, and thus compression of the liver is affected; thus a quarter of an hour's exercise at lawn tennis, at cricket, at boating, or perhaps even better in riding, is more efficacious in stirring up the liver than an hour and a half or even more of a languid constitutional walk. Such is the treatment that ought to be adopted, if possible; but where circumstances render exercise impracticable, the plan is to lessen the quantity of animal food, and to increase the action of the liver by hepatic stimulants. The mere sipping of water is a stimulant of this sort; not only has it the extraordinary action upon the circulation already mentioned, but it increases the quantity of bile and causes it to be secreted under a greater pressure, so much so that it will overcome an obstruction to its entrance to the intestine, such as would otherwise have stopped its flow. A glass of Carlsbad water sipped hot in the morning during dressing is very useful also, and, if necessary, recourse may be had to the powerful hepatic stimulants, euonymine, iridine, leptandrine, podophylline, and others, the action of which has been so carefully investigated by Dr. Rutherford.

Besides these causes of nervous depression which affect both women and men, there is another to which women are liable: the periodical disturbances of the organism, and more especially the diseases to which they are liable, sometimes may induce a state of depression, for the relief of which they have recourse to alcohol. They may be led to indulge in spirits, first of all, by taking alcohol to relieve pain or spasm, or simply by using it to relieve feelings of weakness, depression, and melancholy. This desire for alcohol sometimes continues as long as the disease of the pelvic organs is present, but disappears as soon as the proper measures have been taken for its relief.

Other conditions which lead to depression of the organism and melancholy are: absence of light, and the presence of sewer gas, or arsenical emanations. It is usually said that the rays of the sun falling upon a grate will put out the fire, but their effects on the vital flame in animal organisms are just the reverse; they make it burn more brightly, increasing the oxidation in the body, and quickening and enlivening its functions. The rapidity with which oxidation occurs in the body is estimated by the quantity of carbonic acid given off in a given time. Moleschott found that when frogs were exposed to the sunlight they gave off much more carbonic acid than when kept in the dark, thus showing that the light increases the oxidation within their bodies. Platen made similar observations on rabbits, but found, further, that in them the effect was produced through the eye. This is very much what we would expect, inasmuch as the fur which covers the animal's body would almost necessarily prevent the light from having any action upon it; when the eyes were covered up the excretion of carbonic acid became less, and when the light was allowed to affect them again the excretion was increased. We do not yet know whether the light acts upon the naked skin of the frog as well as upon its eyes, but it is highly probable that it does so. In man also the exposure of the whole surface to light appears to have a tonic or stimulating action; for when I was in New York some years ago I saw at the Roosevelt Hospital a room three sides of which were made of glass, so that the sun could shine into it with the utmost freedom. This I was told was a sun-bath where convalescent patients were allowed to bask entirely naked in the sun's rays—and I was further told that this sun-bath seemed to quicken their recovery and help them to regain their strength. It is obvious, then, that philanthropists ought to endeavour to

secure light as well as air in the dwelling-houses of the poor, and the use of light in promoting health affords an additional reason why vigorous efforts should be made to get rid, as far as possible, of the clouds of smoke and thick fogs which render not only London, but also all our manufacturing towns, so dark and gloomy.

Another unsuspected cause of depression is sewer gas, and poisoning by such gases not only causes diseases of different sorts in the household—sore throats, headaches, coughs, and diarrhœa—but when more diluted they produce loss of appetite, languor, and depression of spirits. It is usually imagined that if no disagreeable smell is felt in the house it is quite safe; but this is not always the case. If bad smells are present we are led to suspect that dangerous gases may be present; but these dangerous emanations may exist without the occurrence of bad smells. In some experiments on this subject, M. Gustave le Bon made a mixture of hashed meat and water, and allowed it to putrefy. He placed a frog in an enclosure with some of the liquid. When putrefaction first began a most fetid odour was evolved, but the frog breathing the effluvium was not injured by it. At this time the liquid swarmed with bacteria, and when injected under the skin of an animal was a most virulent poison. After two months the mixture no longer exhibited such intense poisonous properties when injected under the skin of an animal, and the fetid emanations were greatly diminished. One would naturally have been inclined to think that, as the bad smell disappeared, the danger from the emanations would diminish; but this was not so, for they now proved rapidly fatal to an animal breathing them, although the extremely fetid ones had been innocuous.

Arsenical wall-papers are another unsuspected cause of illness and depression, and their dangerous character is unknown to many, and is disbelieved in by many members of the medical profession. A year or two ago I myself belonged to this number. I received a circular urging united action to prevent the sale of arsenical wall-papers without the purchaser being informed that they contained arsenic. This I threw at once into the waste-paper basket, thinking that the danger alluded to in it was chimerical, inasmuch as I had prescribed arsenic medically to others with good results, and had also taken it myself without any injury—the quantities employed in both cases being, I thought, very much larger than were likely to come from a wall-paper. A month or two afterwards I learnt, by sad experience, how mistaken I had

been. Having chosen an olive-green wall-paper, I asked the vendor whether it was free from arsenic or not; and being solemnly assured that it was, I had it put up. In a very short time indeed after it was hung, I began to suffer from dysenteric symptoms, with intense languor and weakness—symptoms which strongly indicate arsenical poisoning. Again I went to the shop where I had bought the paper, and repeated my question whether the paper was free from arsenic or not. "Oh yes, sir," was the reply; "there is no arsenic in any paper which we sell." The symptoms, however, were so clearly those of poisoning that I submitted a piece of the paper to a professional analyst, and he at once sent back the report, "The paper is loaded with arsenic." Although it was a good while before I recovered from the effects of this, I was much more fortunate than a medical friend, whose wife and himself were both nearly killed by the use of arsenical paint; or another medical man whose children died of symptoms which he was only led, after their death, to associate with the arsenic with which the nursery wall-paper was loaded. Whenever the symptoms of weakness, weariness, and depression disappear on leaving home, and are again felt very shortly after returning, the sufferer should not have recourse to alcohol for stimulation, but should at once have the drains and wall-papers examined.

Depression, as we have already said, may come on from deficient action of the liver, independently of sewer gas or of arsenical papers; but this is not likely to return so immediately after a holiday is over as when the depression depends upon actual though unsuspected poisoning in the house. In all those conditions of depression, and of consequent craving for alcohol which we have hitherto considered, the cause of it, although unknown to its subject, may be readily enough apparent to a medical man who inquires into the matter. But there are other conditions, much more obscure, which lead to drinking. These are probably connected with the original constitution of the man, with the manner in which the nerve-cells of his brain are arranged, and with the tendencies which he has inherited from his ancestors—certain modes of thinking and acting. Those in whom the will is weak and the emotions strong are more liable to the temptations of alcohol than persons of a harder and sterner nature; but in some persons there seems to be a special tendency to drunkenness—a special craving for alcohol apart from any tendency which

the general disposition would lead one to expect. This tendency appears to be due to hereditary want of nervous equilibrium, if we may so call it. This nervous instability shows itself in different ways in different members of a family, or in different branches of a family; perhaps the most characteristic forms being epilepsy, insanity, and drunkenness; thus one member of a family is perhaps noticed to be epileptic, and another is a drunkard. Sometimes the tendency is found, not in brothers or sisters, but in cousins; one cousin, for example, being epileptic, and another a drunkard. There is one form of drunkenness which is, I think, epileptic in its nature: the individual remains perfectly sober for weeks or months together, and then suddenly begins to drink, and remains drunk for several days together; this outbreak is again succeeded by a lengthened sober period. Some years ago I was consulted in regard to a case of this sort occurring in a solicitor's confidential clerk. He was a man of very considerable ability, and the occasional outbreaks of drunkenness would sometimes put a stop to some of the business for two or three days, inasmuch as he was the only man who was acquainted with all the details. Notwithstanding the inconvenience which he occasioned, his services were so valuable that his employers were very unwilling to part with him. The spasmodic occurrence of these fits of drunkenness suggested so strongly to me a case of epilepsy that I prescribed large doses of bromide of potassium, just as one would have done for ordinary fits of this disease, and at the same time moral influence was brought to bear upon him by a clergyman who had acquired considerable influence over him. How much credit is due to the medicine and how much to the moral influence I cannot say; but between the two he was perfectly cured, and has never since had a relapse.

Another case was interesting as showing still more clearly the connection between the two. A gentleman of sober habits went out hunting; was thrown from his horse; he received a severe blow on the head; he was laid up for some time, but again went out three months afterwards, was again thrown, and fell on his head a second time. By these falls two distinct depressions in the occipital region were produced. After the second fall he became subject to occasional fits of drunkenness, combined with epilepsy. Before the fit came on, some change or other could be observed in his countenance, which his wife could perceive, and which warned her of its approach. He then got an irresistible desire to drink,

and if he could get spirits would go on drinking and remain drunk for about two days; then he had an epileptic fit. After the fit had passed off, he would remain perfectly sober for some months, when the desire for drink and the fit would again recur. If he were prevented from drinking, the fit came on sooner after the craving appeared than it would otherwise have done, but it would not be so severe.

In all cases where there is nervous instability, indicating itself either in epilepsy or in a tendency to drink, it is much safer for every member of the family to abstain totally from alcoholic liquor; for with some persons in whom this tendency is marked a single glass seems to have the same effect as the first taste of blood in a tiger; it excites a furious, mad desire for more, and although the person may sometimes resist altogether, if he once tastes, his power of self-restraint is destroyed, and he is irresistibly compelled to drink until he becomes completely intoxicated.

Some persons are induced to drink not by the desire to avoid pain, but by the wish to enjoy pleasure. Sensations of pleasure are, as we have said, connected with active circulation and sense of power, and we find that in the Norseman's *Walhalla* the gods and the souls of the happy dead spent their days in the excitement of fight or of the chase, and at night when the circulation had become quiet after the exertions of the day, they again stimulated their flagging pulses by copious potations of mead.

This condition which the Norseman's fancy pictured as one of perfect happiness after death is what they strove to enjoy as much as possible during their lives. We still find similar conditions among those who have little means of obtaining happiness in any other way. Amongst the mining population of England, for example, we see that too often the working-men try to make themselves happy in their leisure hours by getting drunk, and have almost no idea of getting pleasurable excitement in any other way, except perhaps by fighting themselves, or by watching fights between their mates or their dogs. Amongst others the tendency to drink is acquired by the habit of taking what is called "a social glass." In remote districts of the country, such as in the scattered sheep farms in Scotland and in the north of England, there were (at least before the introduction of daily papers and penny postage) few topics of interest to be discussed when friends met together. The events in the neighbourhood were few, and local topics of conversation being soon exhausted,

nothing was left for them to do but to drink; and alcohol had the double charm of aiding conversation and of giving a pleasurable excitement. The same want of topics for conversation still affects those in this country who are unable to read, or do not care to acquire information.

Emulation is a deeply-rooted instinct in the minds of men and animals, and success in a contest of any kind is a source of great pleasure, while defeat is one of pain. It is, therefore, not to be wondered at that, even when there is neither *ennui* nor want of subject for conversation, those who are fond of the society of their fellows should be induced to indulge in alcohol, if they find that it renders their conversational powers more brilliant, their wit more sparkling, and repartee more ready. They are led to do this not only by the feeling of comfort which alcohol causes in them, but by the distinction and applause which it secures them from their fellows; and to this temptation those who are of a nervous temperament, kindly feelings, and social inclinations are peculiarly liable: good fellows in themselves, their desire to become jolly good fellows is a temptation and a snare. Those of duller temperament, whose powers are not so readily stimulated by alcohol, do not run anything like so great a risk, for in them any pleasure which alcohol may give is probably much less in itself, and is not supplemented by the pleasure arising from successful competition. But it must be remembered that alcohol does not in itself give strength; it only enables a man to draw more rapidly upon his resources. If the calls are not made very frequently, and time be allowed for complete recuperation between each, no harm may be done; but if the demands succeed one another rapidly, exhaustion is sure to occur. The brain which has been stimulated by alcohol to unusual exertion, if called upon shortly afterwards will not respond to the demand unless aided by a repetition of the stimulus; and as it becomes more and more exhausted by the excessive demands made upon it, the amount of the stimulus must be increased. For a while this state of things may go on, but by and by the constant action of the alcohol begins to tell upon the brain; its powers become permanently diminished, the former brilliancy and ability disappear, and then the unfortunate continues to drink not for the purpose of increasing his powers, but for that of enabling him temporarily to forget his weakness and failure, and the sorrow and disappointment which it occasions him. Each repeated indulgence weakens him, further increases his despondency and vexation, and

thus renders the craving for temporary oblivion through intoxication more and more imperative.

But social distinction is not the only object of emulation. In the daily struggle for existence between men engaged in business, success or failure often depends upon clearness of perception, promptitude of decision, and readiness when the occasion arises. Where it is necessary that the man's faculties should be all on the alert, when he knows that the struggle is between himself and other wits as keen or perhaps keener than his own, he is tempted to take alcohol in order to brighten his faculties for the moment and get him successfully over his difficulty. But in the course of business such difficulties arise again and again, and so, if the temptation be once yielded to, the stimulus must be frequently repeated; but the frequent repetition tends to dull the faculties, and thus to render necessary larger draughts as well as more frequent repetition. The men who suffer from temptation of this sort are frequently of harder material and of less emotional natures than those whom we have already mentioned as falling into the snares of social indulgence. They may continue to go on stimulating their powers by frequent small draughts or nips for years together, and though their strong nervous system may resist the direct effect of the alcohol, their other organs suffer, and they die from disease of the liver or of the kidneys. In some the connective tissue increases in the liver (as has already been mentioned), obstruction to the flow of blood through it ensues, the veins of the stomach and intestines can no longer pour the blood into the general circulation, the stomach and intestines become congested, the appetite fails, and when the man goes home after his day's work is over, he finds that instead of taking a hearty dinner he is perhaps able only to take a mouthful or two of soup, and hardly any solid food. To sustain his strength, as he supposes, he takes wine or spirits, and thus matters go on from bad to worse.

Sometimes a vessel gives way in the stomach, and vomiting of blood occurs, which is sometimes so severe as to carry off a patient in a few days, or even hours; or the congestion of the intestines begins to be marked. They become flatulently distended, then fluid is poured out into the peritoneal cavity, and the prominent abdomen, at first resonant and tympanitic, gradually gives a duller note on percussion, as it becomes filled with water instead of wind with the increasing dropsy. In others, again, the kidneys suffer, and gradually become small and contracted: their power of excret-

ing solid substances diminishes; but the quantity of water excreted is on the contrary increased, so that the person is obliged to arise for micturition once or oftener in the course of the night. The products of tissue waste, being imperfectly secreted, begin to tell upon the nervous system; there is a feeling of unwonted weariness and languor, often combined with excessive irritability; this irritability is frequently so great as to excite the astonishment of the individual himself, as well as of his friends. He is not only easily worried, but slight mistakes and errors of omission or commission on the part of others, which at another time would have called forth only a mild remonstrance, excite bursts of furious passion. This condition is by no means free from risk, for it is usually connected with a high pressure in the blood-vessels; if these have undergone degeneration, as they usually do in approaching old age, and have consequently become brittle, the high pressure within may burst one of them in the brain and cause apoplexy, giving rise to paralysis and death. Sometimes, instead of such a termination as this, the waste products accumulate in the blood, produce a condition of drowsiness and stupidity, gradually increasing into complete coma, from which the person can never again be aroused. The conditions we have just mentioned are those which occur in men of powerful organism, but in others the effects of alcohol are intermediate between those we have just described and those which are said to occur in men of more emotional temperament. In some men of business, accustomed to alcoholic stimulants, the nervous system, instead of resisting the effects of the poison, begins to fail, and will no longer sufficiently respond to their accustomed stimulus; in consequence of this they become less successful in business, and lose instead of gaining money. Others again may lose not from any fault of their own, but from circumstances over which they have no control; but the effect of the losses may be the same in both. To escape from the depression which their losses cause, and to enjoy happiness in temporary oblivion, they fly to alcohol. They thus gain temporary relief from misery; but by further weakening their powers, they destroy the last chance which they might have had of retrieving their position, and thus render their ruin certain.

Trials of strength and skill in various games and sports is another subject of competition in which distinction is greatly prized. In such competitions, however, the temptation to take alcohol is reduced almost to *nil*, for there it is found that even slight

alcoholic indulgence greatly reduces the chances of success. In them it is necessary that co-ordination should be as perfect as possible, and the effect of alcohol is to lessen co-ordination temporarily when a single dose of it is taken, and to affect it permanently when it is regularly indulged in. When out on the moors, a glass or two of wine taken at lunch will often so derange co-ordination as to spoil a man's shooting for the rest of the day; and while he has made a good bag in the forenoon, he may go on missing bird after bird in the afternoon. Some of the best shots at Wimbledon have been teetotalers, and Dr. Carver, whose shooting is probably unrivalled, has never tasted a drop of alcohol in his life. The necessity for strict limitation of, if not entire abstention from, alcoholic drinks, is universally recognised in training for races, and it is probable that the man who indulged in a glass of brandy before a boat-race would be execrated by all those interested in his success.

But this truth, so universally recognised by trainers, is not invariably known or acted upon by people in general, and when called upon for unusual physical exertions they will sometimes try to remove the weariness which these cause and gain additional strength and endurance by taking alcohol. Those who are engaged in long walking competitions, such as those of Weston and others, are wiser than to take alcohol during their continuance. The action of alcohol during exertion has been well described by Dr. Parkes in his account of the expedition in Ashanti:—"The first effect of alcohol when given in a moderate dose (for example, what is equal to one fluid ounce of absolute alcohol) is reviving, but this effect is transient. The reviving effect goes off after, at the utmost, two and a half miles of additional march, and sometimes much before this; then the previous languor and sense of exhaustion not only return, but are sometimes more intense; and if alcohol is again resorted to, its effects are now less satisfactory. The reviving power is usually not so marked, and its peculiar anæsthetic and narcotising influence can often be distinctly traced. The men feel heavy, dull, disinclined to march, and are less willing and cheerful." In this description we can see clearly both the stimulating and the narcotic effects of alcohol, inasmuch as the temporary stimulant effect was followed by a condition of dulness and exhaustion greater than if the men had taken nothing at all. At first we might be inclined to attribute this only to the men having been enabled by alcohol to use up their reserve force more quickly, but

a little further consideration will show that Dr. Parkes was, as usual, right in attributing the exhaustion, at least in part, to the anæsthetic and narcotising effect of the alcohol; for on other days beef-tea was served out to the soldiers instead of the ration of rum, and then it was found that while the beef-tea stimulated them as much as the alcohol, it did not leave behind it any depression or dulness. Some might be inclined to say that this result was due to beef-tea being a food as well as a stimulant. This may, to a certain extent, be true, but, as we shall see afterwards, beef-tea is more a stimulant than a food, and in reality supplies scarcely any actual fuel to the. body.

Alcohol is, therefore, not a useful stimulant during prolonged exertion, although it may be taken without harm, or even with advantage, for the purpose of removing fatigue and gaining temporary strength when the distance to be afterwards travelled does not exceed a mile or two at the most.

The effect of alcohol, both when taken in a single dose and when consumed habitually, is modified by active exercise. We all know that exercise warms us. This feeling of warmth, unlike that produced by alcohol, is not due simply to a different distribution of the temperature in the body and to the skin being warmed at the expense of the interior, but is due to the actual development of heat by increased combustion in the body. If we throw into the grate some bad stony coal, which burns with difficulty, we may almost completely put out the fire if it were burning badly before; but if it were previously blazing brightly the new coal will also be consumed, in spite of its slight combustibility—and so it is with alcohol.

When taken by persons leading sedentary lives, and in whose bodies combustion is going on very slowly, it will interfere with the process, and will lead to the grave alterations in the vital organs which have already been described. But when active exercise is taken, alcohol, despite its sparing combustibility in the body, will yet be oxidised in the body. Consequently, fatty degeneration of the liver, heart, and other organs will not occur; and men who are accustomed to constant exercise in the open air, such as shepherds or gamekeepers in the Scotch Highlands, may continue in perfect health and reach a good old age, notwithstanding their consumption of a quantity of alcohol that would bring a man of sedentary habits to his grave in the course of a few years.

The same is true, to a less extent. of men living in towns, but

engaged in hard manual labour. The great amount of muscular exertion required by their work enables them to oxidise alcohol with considerable facility, and thus to take a large quantity with impunity; but the other conditions are not nearly so favourable to them as to the shepherd or gamekeeper: the air they breathe is more or less impure, there is an absence of light, and, as a rule, they probably eat more largely, or, at least, consume more animal food. Active exercise and pure air enable the shepherd to oxidise completely all the food as well as the spirits which he puts into his body, and thus his tissues do not become clogged up with waste products. The impure air, and more abundant diet, prevent this oxidation being so perfect in the case of the town labourer, and thus his tissues and organs suffer. Of course, in speaking of town labourers, we take them as a large class which includes many sub-divisions. In some of these poverty prevents the diet from being anything but extremely meagre, and thus the action of alcohol may in them be considerably modified.

The effect of alcohol is modified also by the condition of the stomach in respect to fulness or emptiness. When the stomach is empty the alcohol comes more readily into contact with its whole surface, and thus exercises a more powerful reflex action on the heart. It is also absorbed more quickly and in a more concentrated condition, and thus produces a greater effect upon the brain. On this account a quantity of alcohol taken fasting will sometimes completely intoxicate a man, when the same quantity taken after a hearty meal would have had comparatively little effect. When a glass of spirits is swallowed immediately after a meal it is at once diluted by the fluids present in the stomach; it becomes mixed up with the food, and so is brought to a much slighter extent, and in a much less concentrated condition, into contact with the walls of the stomach; its reflex effect upon the circulation is, therefore, much less. At the same time, from its intimate mixture with the large quantity of material in the stomach, it cannot be absorbed very readily, and so its effect upon the brain is very much slighter.

For if we disregard the reflex effect produced by any drug upon the other organs through its local action upon the stomach, we find that its effect upon them is in proportion to the quantity circulating in the blood. Now this quantity depends upon two things —or, perhaps, we ought more properly to say upon three. It depends, first, on the rapidity with which the drug is absorbed into

the blood; secondly, on the rapidity with which it is destroyed in the blood or tissues; and, thirdly, on the rapidity with which it is excreted. Now when alcohol is absorbed quickly from the stomach there is little or no time allowed for its destruction in the blood or tissues, nor for its elimination from the body by the lungs, or by the kidneys. The quantity present in the blood, therefore, increases rapidly, and the brain and the heart are much affected. But when it is absorbed slowly, time is allowed for its destruction in the organism, and for its elimination by the lungs and kidneys, so that the quantity present at any moment in the blood is comparatively small, and its action upon the heart and brain is but slight.

The state of concentration or dilution in which alcohol is swallowed has also considerable modifying power. When concentrated, its local action on the stomach, and its consequent reflex action on other organs, is much greater; when diluted, its local action and reflex effects are both much less. When concentrated, it is said to be absorbed more slowly than when diluted; but when only moderately diluted, its comparatively small bulk enables it to be more quickly absorbed than when much diluted, for then its much greater bulk prevents its absorption from being effected so quickly, and allows more time for its destruction and elimination. The effect of diluting alcohol is, therefore, on the whole, to diminish both its local and general action in much the same way as when it is taken upon a full stomach.

The action of alcohol is aided by heat and retarded by cold. Macnish says that he has seen people who could drink eight or ten glasses of raw spirits at a sitting without feeling them much, become perfectly intoxicated with half the quantity made into toddy by admixture with hot water and sugar. He attributes this, but I think wrongly, to the stomach being habituated to the strong spirits, and not to the diluted spirits. The effect is rather to be attributed to the heat of the mixture, which by stimulating the heart accelerated the circulation, and thus aided the effect of the alcohol; though perhaps the greater effect may also be partly due to the more rapid absorption of the toddy than of the raw spirits.

But hot toddy has sometimes a soothing and sudorific, instead of a stimulating, action; and persons who suffer from sleeplessness sometimes find this relieved more readily by hot brandy and water than by any narcotic. The reason of this is, that the condition of sleep is associated with a scanty supply of blood to the brain,

whereas mental activity requires an abundant supply. But the quantity of blood in the body is limited, and if more goes to one part less must go to another. Consequently, if there is much in the stomach there must be little in the head, and *vice versâ*. Everybody knows the drowsiness which comes on after eating, and knows also the effect of hard mental work immediately after a meal in hindering digestion. Long ago this was explained by Mayow on the supposition that thought and digestion were both carried on by what he called "vital spirits." These spirits came down from the brain to the stomach in order to digest, and after the work was done went back to the brain, in order to think; and as they could not be in both places at once, digestion and thought could not go on at the same time. If in place of Mayow's "vital spirits" we read "blood," his theory will very nearly represent the opinions of the present day. When digestion is going on the vessels of the stomach and intestines become filled with blood; the supply which is available for the brain is therefore diminished, and the person goes to sleep. When the brain is active it takes more blood, and consequently there is less for the stomach; so that mental activity after a meal interferes with the digestion by drawing away the blood from the stomach.

A glass of warm spirits and water taken at night into the stomach dilates the vessels there, and by thus drawing blood away from the brain enables the person to sleep. But the mixture of spirits and water has the disadvantage that it tends to stimulate the heart, as well as to dilate the vessels of the rest of the body; so that, if it does not produce sleep, it will make the person more wakeful than before. A similar result, and sometimes a better one, can therefore be obtained by using, instead of hot spirits, a large bowl of weak beef-tea or of panada. Heat itself is a stimulant to the heart, and as we do not wish the heart stimulated, but only the vessels of the stomach dilated, while these things, then, should be warm, they should not be too hot. A wet compress over the abdomen is sometimes better than anything taken internally, and is especially useful for sleeplessness in children. Where a local compress fails, a wet pack sometimes succeeds.

What I have just said regarding the effect of heat and cold may seem at first sight to be contradicted by the fact that persons who have been drinking spirits in a warm room without experiencing any marked effects may become suddenly intoxicated when they go into the cold air. Two reasons might be assigned for this: one is

that, from the coldness of the air, the elimination through the lungs may be checked, while absorption is still going on from the stomach, and thus the amount of alcohol in the blood is increased. The other and probably the true reason is, that the cold air acting upon the vessels of the skin, which have not yet been completely paralysed by the alcohol, causes them to contract, and thus drives more blood to the internal organs and to the brain. The brain thus receives alcohol in larger quantities than before, and the paralysing effect of the alcohol upon it is thus more rapidly produced.

In one of his charming stories from German history, Gustav Freytag describes a drinking duel between the hero Ingram and another German. Whoever first became intoxicated was declared vanquished, and the great object of each was to prevent their attention being distracted, because, when the parties were at all equally matched, the least thought or emotion at once caused intoxication, and consequent defeat.

The effect of attention may be explained in the same way. It is known to habitual drunkards that if they wish to drink much they must allow others to do the talking, for they will become affected much more readily by alcohol if they join in the conversation. Now, conversation implies mental exertion, and mental exertion is connected with a freer flow of blood to the brain. The freer the flow of blood, the more alcohol will be carried by it to the brain, and therefore the more rapidly will the mental faculties suffer.

Forms of Alcohol.

Having considered the modifications produced in the action of alcohol by the alterations in the organism, we have now to consider its effect as modified by the different forms in which it is taken. The chief forms are: spirits, wine, and ales. Each of these three classes contains several subdivisions.

Alcohol consists of the three elements: carbon, hydrogen, and oxygen. For convenience sake the initial letters of the Latin names of the elements are used to designate them. But these letters indicate more than simply the presence of the element: they indicate its presence in a given quantity. For it has been found that elements always combine in definite quantities, or

multiples of these quantities; and these proportions are: 12, 1, and 16, for carbon, hydrogen, and oxygen respectively. C, then, always signifies twelve parts by weight of carbon; H, one part by weight of hydrogen; and O, sixteen parts of oxygen. These numbers are called the combining or atomic weights of the elements, and are supposed to represent the relations between the weights of the smallest possible portion or atom of each substance.

We may have not only union between single atoms of each element, but between several atoms; thus in alcohol we have union between two atoms of carbon, six of hydrogen, and one of oxygen. This is represented by a formula thus: C_2H_6O, and this formula shows us, not only that carbon, hydrogen, and oxygen are contained in alcohol, but that there are twenty-four parts by weight of carbon, six of hydrogen, and sixteen of oxygen. When it is put into a spirit lamp and burned, it unites with the oxygen of the air and forms carbonic acid and water, heat being given off at the same time. The chemical changes which occur between the atoms of carbon, hydrogen, and oxygen in the process of combustion is represented by the formula:

$$\underset{\text{Alcohol.}}{C_2H_6O} + \underset{\text{Oxygen of Air.}}{O_6} = \underset{\text{Carbonic Acid Gas.}}{2\,CO_2} + \underset{\text{Water.}}{3\,H_2O}$$

Alcohol has been prepared chemically in several ways. It has been found in small quantities by a direct union of the elements; but, practically, it is always made by the fermentation of sugar. All kinds of sugar are not alike: one which is called grape sugar, and which may be seen occurring in small hard masses in raisins, has the formula $C_6H_{12}O_6$. Another sugar, called from its source cane sugar, may be also used for preparing alcohol, but in the process of fermentation it first is changed into grape sugar, and afterwards into alcohol.

The change which occurs in grape sugar is that it splits up into alcohol and carbonic acid; the alcohol remains in solution and the carbonic acid passes off. This gas has powerful asphyxiating properties, and it is from it that so many deaths by suffocation have occurred in brewers' vats. The formula representing this change is—

$$\underset{\text{Grape Sugar.}}{C_6H_{12}O_6} = \underset{\text{Alcohol.}}{2\,C_2H_6O} + \underset{\text{Carbonic Acid Gas.}}{2\,CO_2}.$$

When the mixture of alcohol and water, which is produced by the fermentation of the solution of grape sugar, is subjected to

distillation, the alcohol passes off much more easily than the water, and so a strong spirit is obtained in the distillate, a great portion of the water remaining behind; the distillate, however, still contains some water, from which it may be freed by mixing with lime and re-distilling.

Pure or absolute alcohol is lighter than water, and has a great attraction for it, so much so that it will absorb it very readily from the air; when mixed with water it unites quickly with it, and gives rise to heat. It burns very readily with a blue flame and with no smoke. The more water that is mixed with it the less readily does it burn, until at length it will not burn at all, but will rather put out the fire. This property was formerly employed as a rough method of ascertaining its strength: a little of the spirit was poured on to gunpowder, and set on fire; if the spirit was strong the gunpowder exploded, but if the spirit was weak it damped the gunpowder so much that it would not take fire; when the gunpowder exploded the spirit was said to be *above proof*, and when it would not explode the spirit was said to be *under proof*.

We will first compare the action of the divisions—spirits, wines, and ales—with each other, and then we will compare the action of the different kinds of spirits, wines, and ales among themselves. The first difference we note between spirits and the other two groups is that of concentration. Almost all kinds of spirits contain from about 40 to 58 per cent. of alcohol by weight, wines from 8 to 20, and ales 1 to 10. Thus we see that, roughly speaking, wines are as a rule twice as strong as beer, and spirits twice as strong as wines. A glance at these numbers will show that the strong ales are stronger than the light wines.

Spirits are composed chiefly of alcohol and water, though each kind of spirit has a peculiar flavour which it owes to another kind of alcohol or ether. Wines contain a larger proportion of ethers, colouring matter, and some tartrate of potash. Ales differ from the other two in containing less alcohol, and little or no ether; but contain some sugar and some gluten, as well as a little mineral matter. They almost invariably contain also the extract of hop. The distinction between ale and beer originally was, that beer contained hop and ale did not; but now both beers and ales contain hop; and the difference is simply that the proportion of the bitter extract of hops in ale is less than in beer. It is therefore sweeter, as well as of a lighter colour.

From their greater concentration spirits have a much greater

local action, and produce more powerful reflex effects than wines or ales. When applied to the unbroken skin alcohol evaporates rapidly, and especially when the part is fanned or blown upon so as to increase the evaporation, alcohol produces a sensation of great cold. If its evaporation is prevented by placing over it a piece of waterproof tissue, it penetrates through the scarf skin, or epidermis, to the true skin below, and there has a similar action to what we have already described as occurring in the mouth. It partially and temporarily coagulates the albuminous substances, and produces irritation and redness. In this respect, too, brandy or whisky will have a similar effect to that of pure alcohol, though not quite so powerful.

When taken into the stomach, evaporation being prevented, spirits also cause much local irritation. Strong wines have little or no effect on the unbroken skin, but when taken into the mouth, acting more readily on the delicate mucous membrane, they produce a sensation of warmth, and this is sometimes felt to a disagreeable extent as they pass down the gullet in persons who are suffering from abnormal irritability of that part.

The alcohol in ales and beer is so diluted as to produce no action on the skin, and but little on the mouth. The hops and carbonic acid which they contain cause, however, a pleasing stimulus by their sharpness and transient bitterness. The bitter of hops differs from that of other bitters, in producing a very temporary effect upon the organs of taste, and to this quality its pleasant effect is chiefly due. The sensation of bitterness is in itself disagreeable to most persons, and when, like that of strychnia, it is persistent, it becomes very disagreeable. Quinine also, when taken in nearly a neutral solution, produces a very persistent and disagreeable bitter taste. But if it is taken with sufficient acid to keep it thoroughly in solution, even when it comes in contact with the alkaline mucous membrane of the tongue, and when it is followed by a draught of water, it leaves upon the tongue, instead of a bitter, a pleasant sweetish taste. The taste of the quinine itself is disagreeable, but the after-taste is very pleasant; and the bitter of hops, being very transient, leaves a pleasant impression.

The local effect of alcoholic drinks upon the stomach is like that upon the mouth. It is powerful in the case of spirits, moderate in the case of strong wines, and slight in the case of weak wines and ales. When a man wishes to stimulate his digestion, and prevent something which he has taken from disagreeing with him, as, for

example, when he has taken a lobster supper, he takes a small glass of spirits, and not several tumblers of beer. The reflex action on the circulation is also great in the case of spirits, moderate in that of strong wines, and small in that of weak wines or ales. When a person is fainting, and we wish to stimulate his circulation quickly, we give him a glass of spirits or of port wine, rather than half a tumbler of claret or a glass of ale.

The effect of wines, beers, and spirits on the process of digestion in the stomach is one of very great importance indeed, but is very difficult to decide satisfactorily. On the one hand, we know that alcohol in certain quantities will harden meat, and thereby interfere with its digestion; that it will further precipitate pepsine and peptones; and that in large quantities it will also stop the secretion of gastric juice, increase the secretion of mucus, and even lead to vomiting. On the other hand, we know that small quantities are among the most powerful stimulants to the secretion and movements of the stomach which we possess, and therefore we are inclined to suppose that they would greatly facilitate both the digestion and absorption of food.

The result of special experiments is here contradictory; and the result of the experiments made on a large scale by people in general is also contradictory; for while the great majority of people in Europe, at least, drink alcohol in one form or another, with such of their meals as contain albuminous matter in the form of flesh or cheese, a certain number find they are better without alcohol in any form, and that when taken with their meals in small quantities and in a diluted form it deranges their digestion. To settle this difficulty some experiments were made a short while ago by Buchner under the direction of Professor Leube.[1] These experiments were made in two ways—first, by treating boiled white of egg with a digestive fluid in glasses maintained at the temperature of the body. To the digestive mixture in one glass no alcohol was added; to the others alcohol was added in various proportions and in different forms, as wine and beer. The result of these experiments was, that when alcohol was added in quantities only sufficient to form 10 per cent. of the whole liquid in the glass, it had no effect upon artificial digestion, but that as the quantity was increased from 10 to 20 per cent., the digestion went on more and more slowly, and that when more than 20 per cent. was added, digestion was entirely arrested.

[1] *Deutsches Archiv für klinische Medicin*, XXIX., p. 537.

Experiments with wines showed that they interfered with digestion to a greater extent than could be explained by the quantities of alcohol they contained. Contrary to expectation, the French red wines interfered more with digestion than the white German wines. One of the worst of all was marsala, and one of the least objectionable was sparkling hock. The reason why wines should interfere more with digestion than a corresponding quantity of alcohol was not determined.

Beer also, contradictory to expectation, was found to interfere very much more with digestion than a corresponding quantity of diluted alcohol, and this result was possibly due to the salt, and especially to the phosphates, it contained.

But experiments made with digestive fluids in a glass, while they may give us an approximate idea of what is going on in the stomach, do not correspond at all exactly to the conditions in the living body. For in the stomach we have to consider not merely the solution of the food in the gastric juice, but the secretion of this juice itself, the movements of the stomach, and the rapidity of absorption. In order, therefore, to obtain some trustworthy data regarding the action of various forms of alcohol on digestion in the stomach, Buchner washed out the stomach of some patients by means of a syphon six hours after dinner, and saw whether any undigested remnants of the meal were still present after that interval. Sometimes he allowed them to drink water alone, at other times beer or wine, with their dinner, and drew his conclusions regarding the effect of these drinks upon digestion from the presence or absence of any food in the stomach when he washed it out. From consideration for his patients, who were almost entirely women, he made no experiments either with alcohol, with brandy, or any other form of spirits, but only with beer and wine. The results that he obtained were, that both wine and beer, even in small quantities, interfered with digestion; but when the stomach was healthy, this interference was not so great as in the experiments made with artificial digestion in glasses. Whenever the stomach was deranged, and gastric catarrh was present, the results of experiments on the living body approached more nearly to those on artificial digestion in glasses, and the deleterious influence of wine and beer upon digestion was increased to such an extent as sometimes to arrest it altogether. This result corresponds with the clinical observations of Professor Leube, who has been accustomed for years back to avoid every form of alcohol in cases of

gastric catarrh; or if he thought necessary to administer it, has only done so by means of enemata.

The injurious effects of alcoholic liquors on the stomach and intestines have been particularly studied by Professor Leudet (*Lyon Médical*, tome xli., p. 123). These effects differ according to the manner in which the intoxicating liquor is taken. People in easy circumstances take it regularly and continuously without ever getting drunk; artisans, on the contrary, take considerable quantities of alcohol at one time, once or twice in the week. These two modes of absorption produce different lesions. M. Leudet has not paid any attention to the different kinds of alcohol, but thinks that it is in the continuity of its deleterious action rather than in the kind taken, that we must look for the cause of the lesions in the easy class. In the artisan class, where the alcohol is drunk rapidly, gastro-enteritis is found, which is of a more or less acute character. Among well-to-do people, gastritis of a superficial catarrhal character is chiefly found, and enteritis occurs especially among wine merchants. In fact, the man who never gets drunk, but who is continually drinking, has almost always loose and never firm motions. This enteritis and this liquid condition of the motions may last for twenty or thirty years; the motions are catarrhal and not dysenteric. On the other hand, the workman who gets drunk once or twice a week, but hardly touches liquor at other times, suffers rather from constipation. The well-to-do drunkard often suffers from a tendency to bleed from the nose or from the stomach, from the kidneys or from the liver; he has also a tendency to atheroma. Among rich people glycosuria may occur at the age of thirty-five years. In such persons enteritis is very serious, and is accompanied by hepatic complications, such as hypertrophic cirrhosis, which may last seven or eight years, while such affections are very rare in the artisan.

The effects upon the nervous system of wines, beers, and spirits are due: first, to their reflex action on the circulation; and secondly, to their effect upon the brain and nerve centres after absorption.

The stimulant effect of spirits upon the circulation is greatest, and that of beer is least.

The action upon the nerve centres is also most rapid in the case of spirits, and slowest in the case of beer. On this account, the restraining powers of the nervous system being paralysed, while the lower centres are still undergoing greater stimulation, there is a greater tendency to wild excitement from spirits than from either

wines or beer. Strong wines have an action similar to spirits, whereas weak wines more resemble beer.

In the case of wines, however, the stimulant effect of the alcohol which they contain is modified by the ethers which give to the wines their bouquet. It is probably in consequence of this that wines have a tendency to cause hilarity and an excitement of the emotions, feelings, and thoughts, whose effects are confined to the individual himself, rather than the tendency to movements of aggression upon others, which spirits have a tendency to produce.

The effect of alcohol in beer is modified by the hops. This substance has a somewhat soporific action, and beer has therefore a greater tendency to produce drowsiness and sleep than either spirits or wines.

The effect on the general nutrition of the body of wines and spirits is also different. The different appearance of the spirit and beer drinker has been illustrated by Hogarth in his "Beer Street" (Plate II) and "Gin Lane" (Plate III), where he depicts the beer-drinker as large, fat, and bloated, the gin-drinker as thin and emaciated. As a good example of the wine-drinker, we may take the gouty old Squire in the first picture of the "Marriage à la Mode" (Plate I, Frontispiece). There we see him neither thin and emaciated, nor fat and bloated, but with full, rounded, firm cheeks, smooth skin, and a general well-fed, well-cared-for look. Unlike the gin-drinker, his body is amply nourished; and, unlike the beer-drinker, he has no tendency to the accumulation of waste *non-nitrogenous* products in the shape of fat. He too, suffers, but his sufferings are due to the accumulation of *nitrogenous* products. Excess of uric acid and urates in his tissues render him irritable and choleric, while at the same time they cause gouty inflammation in his toes, which chains him to his chair like a prisoner, and occasionally subjects him to the tortures of the Inquisition.

Perhaps the most noticeable instance of the effect of the substances combined with alcohol in certain forms of spirits is to be found in the action of absinthe. This consists of strong spirit flavoured with oil of wormwood, and this oil has a marked physiological action of its own. Absinthe, when given in small doses to animals, causes giddiness, accompanied by an abrupt succession of muscular jerks, as if numerous electric shocks were being passed through the animal. In larger doses it produces epileptic convulsions, and causes also delirium with hallucinations. This delirium comes on quite suddenly, instead of coming on

BEER STREET.

Beer, happy Produce of our Isle
Can sinewy Strength impart,
And wearied with Fatigue and Toil
Can chear each manly Heart.

Labour and Art upheld by Thee
Successfully advance,
We quaff Thy balmy Juice with Glee
And Water leave to France.

Genius of Health, thy grateful Taste
Rivals the Cup of Jove,
And warms each English generous Breast
With Liberty and Love.

[*To face p.* 130.

gradually like that of alcohol, and the hallucinations produce agitation and appearances of anger or fright in the animal. In man, the muscular shocks and giddiness which are so perceptible in animals also occur to a slight extent, but are less marked. Unless one were on the watch for them they might pass unnoticed, being represented simply by trembling and giddiness, which might be regarded as due to the alcohol alone. But when intoxication is complete, it is accompanied by epileptic seizures which are not produced by alcohol.[1]

These convulsions are due to the action of the absinthe, not upon the cerebrum, but upon the medulla. They usually terminate favourably, but in some cases they occur in rapid succession, with intervals of only five or ten minutes between them. Then the case is very grave, and at the third or fourth attack death may occur; or the person may remain in a state of coma ending in death.

Brandy ought to be made by the distillation of wine, and when prepared in this way is one of the purest and least injurious forms of spirit. It then contains, in addition to alcohol and water, small quantities of acetic, œnanthic, butyric, and valerianic ethers, and small quantities of grape sugar, colouring matter, tannin, and acid.

Its action, when pure, is very much like that of pure alcohol, although probably the ethers present in it render it slightly more stimulating to the secretion of digestive juices, and tend to render the intoxication it produces more gay and less furious.

But a great deal of brandy is simply made from spirit by the addition of some bitartrate of potash and prunes, acetic ether, tannin, and burnt sugar. Sometimes a little real brandy is added to it, and sometimes an artificial mixture of œnanthic ether and other substances, made by distilling palm oil with sulphuric acid and spirit. Such brandy as this is of course much more injurious, both to the nervous system and stomach, than the pure spirit.

Whisky is prepared by the distillation of malt, and it contains fusel oil, or amylic alcohol, in addition to ordinary alcohol. This fusel oil is much more injurious to health than ordinary alcohol, being, according to Rabuteau, fifteen times more powerful. Its vapour causes aching and heaviness of the head, and in animals will produce complete anæsthesia. It seems probable that in old

[1] *On Alcoholism*, by Dr. V. Magnan, translated by W. S. Greenfield, M.D., pp. 22 and 73. London: H. K. Lewis.

whisky a good deal of the fusel oil is converted into ether, or at least enters into some compound in which it is less injurious than it is in new whisky. New whisky appears to have a much more powerful and injurious action upon the brain than old, and seems especially to produce a greater tendency to violence. The observations made on the effect of very old whisky are not numerous. A friend of mine told me that on one occasion, while dining with a gentleman who had some exceedingly old whisky, the guests complained that it was so old that it had lost its strength. It had no fiery taste, nor did it seem to produce any effect upon their intellects while they sat drinking it. But when they rose to go to the drawing-room, they found they were hardly able to walk, the cerebrum seeming to have been left almost unaffected, while the functions of the cerebellum were greatly impaired. In considering this observation, however, we must be careful not to attribute the effect altogether to the quality of the whisky, but partly to the form in which it was taken. It had been mixed with hot water and gradually sipped, so that its action was distributed over a length of time; if taken pure it might have had a different action.

Curious differences are said to exist also in the action of different kinds of liquors on the equilibrium when taken in excess. Good wine or beer is said to make a man fall on his side, whisky, especially Irish whisky, on his face, and cider or perry on his back.[1] These disturbances of the equilibrium correspond exactly to those caused by injury to the lateral lobes, and to the anterior and posterior part of the middle lobe of the cerebellum respectively.[2]

The greater excitement and tendency to fury produced by new whisky may not be entirely due to a difference in the mode of action between fusel oil and alcohol, but may be partly caused by the more powerful intoxicating properties which the admixture with the strong fusel oil imparts to the spirit. For where intoxication is produced rapidly there is usually a greater tendency to violence, and this tendency is also more marked in powerful and muscular individuals.

Gin is a spirit flavoured with juniper berries, and also in some cases with cardamom, grains of paradise, coriander seeds, cassia buds, angelica root, calamus, and orris root. The chief effect of

[1] Shorthouse: Bailey's *Magazine of Sports*, 1880, vol. xxxv. p. 396.

[2] Ferrier: *Functions of the Brain*, London, 1876, pp. 94 and 96.

these substances in modifying the action of the alcohol in the gin is not so much exerted on the nervous system itself as upon the excretory organs: the kidneys being stimulated by the oil of juniper to greater functional activity, so that alcohol also may be more rapidly eliminated from the body in this form than is the case with other kinds of spirits.

Rum is obtained by the distillation of molasses, and is usually kept for a long time in oak barrels. It is said thus to acquire a larger quantity of astringent matter than other forms of spirit, to have a less irritating action on the stomach, and to be more useful both in gastric and pulmonary catarrh than other spirits.

Koumiss is an alcoholic drink which the Tartars prepare by fermenting mare's milk. It is used both in Russia and this country, but its use here is almost confined to invalids.

The effect of continued indulgence in spirits leads to chronic disease of the various organs of the body. The brain suffers; and its functions, which are temporarily paralysed during intoxication, are gradually but permanently weakened in much the same order by long-continued indulgence. Thus the judgment becomes less clear, the will less powerful, and the sense of the individual's relation to others much impaired. He becomes vacillating, more selfish, and less true. In some cases, indeed, the tendency to untruth becomes so great that no reliance whatever can be placed upon the person's word. Sometimes it is doubtful whether the lying is deliberate, or whether it is really due to what one sometimes sees in children—a complete inability to distinguish between the facts of the external world and the creations of their own fancy. Even in healthy adults we find this difficulty under exceptional circumstances. When one is asked regarding an event which happened some years ago, he will probably give a perfectly correct answer. But if first one, and then another, and perhaps a third, says to him, "Are you quite sure it was so-and-so?" "Did it not happen in such-and-such another way?" he may begin to doubt the truth of his recollection, and finally believe that the occurrence took place in the way suggested by others. His imagination, awakened by his friend's questions in this case, may completely overpower the correct recollection which he has of the facts as they actually happened. In children, the imagination, without any suggestion from without, appears sometimes to overpower the recollection. In drunkards the same is apparently

the case, and this is aided by the impairment of memory, which is also one of the consequences of chronic alcoholism.

The physical lesions to which these mental changes are due appear to consist partly in alteration of the vessels which supply the nerve centres with blood, and partly to alterations in the nerve centres themselves. The nerve cells and fibres, to which the activity of the nerve centres is due, are held together by connective tissue. In chronic alcoholism this becomes much increased, and, pressing on the nerve cells and fibres, causes them gradually to waste away.

Besides those alterations in the character and mental powers just described, headache, weight in the head, buzzing in the ears, and giddiness occur frequently in chronic drunkards. They suffer also from numbness, tingling or pricking in various parts of the body, especially in the soles of the feet and palms of the hands, and sometimes in the leg and arm of one side. Sometimes there is greater, sometimes less, sensitiveness to impressions made upon the surface of the body; there may be weakness or trembling of the extremities; and the bladder and rectum may be affected in such a way that their contents are either allowed to escape involuntarily or spasmodically retained.[1] The alterations in the stomach and intestines occasioned by alcohol, and the symptoms they produce, have already been mentioned.

The marked difference between the appearance presented by the spirit-drinker, the wine-drinker, and the beer-drinker, as exemplified in Hogarth's pictures, is probably partly due to the effects of these different drinks on the alimentary canal, and partly to their effects upon tissue change.

The alcohol in spirits, in wine, and in beer, after it has once been absorbed, will tend to prevent the combustion of other substances in the body; and, undergoing combustion itself, will to some extent act as a food. But the local effects which it produces on the stomach and intestines, when taken in the form of spirits, will prevent other food from being eaten or assimilated to a sufficient extent, and thus the person will be more or less starved, and become thin and miserable. This will not always be the case; and so one may find that at one period the spirit-drinker may present a well-nourished appearance, similar to that of the wine-drinker, or may be even bloated like the beer-drinker. So long as the stomach and intestines are not injured by the spirit,

[1] Magan, *On Alcohol*, p. 155.

GIN LANE

Gin cursed Fiend, with Fury fraught,
Makes human Race a Prey.
It enters by a deadly Draught,
And steals our Life away.

Virtue and Truth, driv'n to Despair,
Its Rage compells to fly,
But cherishes with hellish Care
Theft, Murder, Perjury.

Damned Cup! that on the Vitals preys,
That liquid Fire contains
Which Madness to the Heart conveys,
And rolls it thro' the Veins.

[To face p. 134.

and so long as the drinking customs of the individual have not reduced him to such poverty as to prevent him from getting as much food as he wants, the nutrition of the body may not suffer, or may indeed appear to be increased; but when either the digestion is destroyed by continued alcoholism or the circumstances of the drunkard lessen his supply of food, then emaciation will occur.

Wine has a less powerful local effect upon the stomach and intestines, and is less likely to destroy the digestive powers than spirits. At the same time it does not contain any nutritious substances in addition to alcohol, and so it does not tend of itself to fatten. Consequently the wine-drinker is neither emaciated like the gin-drinker, nor bloated like the beer-drinker.

As the beer-drinker takes beer in addition to other nutriment, he has a tendency to become fat and bloated at one time, although he may afterwards become thin and emaciated, from his digestion also suffering like that of the spirit-drinker. Notwithstanding the apparent stoutness and strength of beer-drinkers, they are by no means healthy. Injuries which to other people would be but slight are apt to prove serious in them; and when it is necessary to perform surgical operations upon them, the risk of death is very much greater than in others. On carefully looking at the beer-drinker, we see that instead of his flesh being firm, the fat which overloads it is of a somewhat soft consistence, as if the cellular tissue did not contain firm fat alone, but contained moisture along with it. The constant use of alcoholic liquors, indeed, has a tendency to produce watery exudations, either in the cellular tissue or in the cavities of the body generally. This becomes evident in the later stages of drunkenness in the form of dropsy, and has given rise to the old proverb, *Vivit in vino moritur in aqua* (He who lives in wine dies in water).

At first the fat, which is very soft, is deposited chiefly under the skin, between the muscles and in the abdomen. In the later stages, when the individual begins to waste, its place is taken by a sort of gelatinous mass, and at a still later stage dropsy occurs. The skin itself is at first soft, with a slight satiny feeling, from which I have seen Professor Neumann discover the alcoholic tendencies of a patient; and perspiration is easily induced. Later on, the skin becomes thick and discoloured, sometimes red and sometimes sallow, and becomes liable to various diseases, the best known of which is acne rosacea, often called bottle-nose. Besides

this, the skin may be affected with inflammation of various sorts, leading to the formation of ulcers, vesicular, scaly, or pustular eruptions, boils, and abscesses.

Besides rendering men more liable to death from injuries, or from surgical operations which would otherwise have been recovered from, alcohol tends indirectly to induce disease. Some of these have already been mentioned—viz. delirium tremens, mania, degeneration of the nervous system, and chronic catarrhal conditions of the stomach and intestines. The morning vomiting and chronic gastro-intestinal catarrh which occur in drunkards have already been described. This catarrhal inflammation not unfrequently leads to ulceration. But besides these affections, alcohol, more especially perhaps in the form of gin, and to a less extent in that of other kinds of spirits, tends to produce degenerative changes in the liver, lungs, and probably in the kidneys.

These changes are chiefly of two kinds—firstly, the increase of fibrous tissue already described, which tends to press upon the proper structure of the organ, and causes it to waste away; secondly, a fatty transformation by which the tissues which ought to compose an organ are transformed more or less completely into fat.

The liver being thus affected leads to indigestion, and later on to bleeding from the stomach or intestines, and to dropsy. The kidneys undergoing degeneration, the excretion of the waste products of the body is interfered with, and their retention in the body leads to a form of poisoning, the patient becoming comatose and dying in stupor.

Spirits have a tendency to cause both forms of degeneration, fatty and fibrous, but more especially the fibrous form. Beer has a tendency to cause chiefly the fatty form of degeneration. Nor are wines free from ill effects, as we see from the figure in Hogarth's picture already alluded to, which we have taken as typical of the wine-drinker. Port wine more especially tends to produce gout; but other wines are not free from this tendency. In gouty subjects, or those who suffer from rheumatic gout, a single glass of port wine will often produce painful twinges, and a similar effect is not unfrequently noticed from hock. Such persons can sometimes drink claret or spirits in moderation with little or no bad effect, but occasionally rigid abstinence from these also is necessary. Dr. Garrod says that the use of fermented liquors is the most powerful of all the predisposing causes of gout—nay, so powerful that it may

be questioned whether gout would have ever been known to mankind had such beverages never been indulged in.[1]

The different effects of spirits, wines, and ales in producing gout is seen by comparing the number of cases which occur in different countries. Sir Robert Christison, during thirty years' experience in the Royal Infirmary at Edinburgh, only met with two cases of gout, and both of these were fat and overfed English butlers. Dr. Hamilton, during the same time, had only two cases, and Dr. Gregory had only two, out of 2,200 patients. In other parts of Scotland, as well as in Ireland, where the people drink whisky, gout is also absent; and the Russians,[2] Poles, Swedes, and Danes are also free from it, although they drink large quantities of spirits.

The greater power of wine than of small beer to produce gout is shown in the observations of Van Swieten on the Dutch, and Linnæus on the Laplanders.[3] Both were comparatively free from gout until wine was introduced, and then the disease became more common. But though small beer, as shown from these observations, has little tendency to induce gout, strong ales and porter produce it readily. This has been noticed by Dr. Budd in the men employed in raising ballast from the bottom of the Thames during the ebb tide, who drink large quantities (sometimes two or three gallons) of porter daily. These men are mostly derived from the Irish peasantry, and have no hereditary tendency to gout; but this enormous consumption of beer induces the disease, so that many of them are affected with it. A few years' liberal indulgence in port or sherry will of itself, according to Dr. Garrod, produce gout even when no hereditary tendency exists. The light kinds of claret, hock, and moselle have little tendency to induce gout, and the population of France and the Rhine provinces are but little affected with it. The stronger kinds of these wines will both excite an attack of gout in persons already subject to the disease, and tend to produce it of themselves, as is seen in some of the larger cities of France and Germany. Champagne often excites an attack in gouty persons. This tendency is less when the champagne is dry than when it is fruity. Cider, when fully fermented and free from sugar (usually termed rough cider), has little power of inducing gout, but partially fermented (or sweet cider) may excite an attack of gout in persons predisposed to it.

1 Garrod, *On Gout and Rheumatic Gout.* Third edition, 1876.
2 As I am verbally informed by Professor Horvath, of Kiev.
3 Garrod, *Op. cit.* p. 219.

The excessive use of alcoholic drinks has been said to cause dysentery, especially in tropical climates; but this does not seem to be perfectly established. The whole subject of the relation of alcohol to dysentery is well discussed in the *Medical and Surgical History of the American War*,[1] and the conclusion arrived at is that it is highly improbable that there is any direct connection between the use and abuse of ardent spirits and the causation of dysentery; and yet it is so well established that habitual intemperance impairs the general health of the drunkard, and that dysentery, when it occurs epidemically, is especially prone to seize upon those whose general health is impaired by any cause, that it is probable that drunkards may be somewhat more subject to attacks during the epidemic prevalence of the disease, and still more so that, as is often alleged, the disease is more fatal to patients of this class when attacked than to temperate persons.

In drunkards there is a great tendency to chronic catarrh of the respiratory passages; the back of the throat is often red and congested. This congestion extends down to the larynx, giving rise to hoarseness and expectoration of mucus. It very frequently extends also down the smaller bronchi, so that drunkards are rarely free from some form or other of chronic bronchitis. In them also there seems to be a marked tendency to acute inflammation of the lungs and pleura. When actually attacked by inflammation of the lungs, their chance of recovery is much less than that of a sober person, inasmuch as there is a greater tendency for a condition of œdema to appear in those parts of the lung not affected by the inflammation, and rapid death is the result.

The effect of alcohol upon longevity is most decidedly injurious.

In intemperate persons the mortality between twenty-one and thirty years of age is five times as great, and between thirty and forty years of age four times as great as that of the temperate. It becomes gradually less with advancing years, but at every age the abstainer has the advantage.

An Intemperate Person's chance of living is :	A Temperate Person's chance of living is :
At 20—15·6 years.	At 20—44·2 years.
„ 30—13·8 „	„ 30—36·5 „
„ 40—11·6 „	„ 40—28·8 „
„ 50—10·8 „	„ 50—21·25 „
„ 60— 8·9 „	„ 60—14·285 „

1 Vol. i., part 2, p. 622.—*Op. cit.* p. 192.

If persons have once begun habits of intemperance, the average duration of life is among—

Mechanics, working, and labouring men	18 years.
Traders, dealers, and merchants	17 „
Professional men and gentlemen	15 „
Families	14 „

The mortality is greater in temperate persons who drink spirits than in those who drink beer, and the mortality is slightly greater when both spirits and beer are drunk than when either is drunk alone.

Another striking proof of the increase in longevity caused by total abstinence from alcohol, even as compared with its moderate use, is given by the statistics of the United Kingdom Temperance and General Provident Institution. This office consists of two sections—one of total abstainers, and another of moderate drinkers. Intemperate persons are of course excluded, as neither this nor any other insurance company will accept the lives, on any terms, of persons who are known to be intemperate. The two sections are exactly alike in every other respect, about twenty thousand lives being assured in the general section, and ten thousand in the temperance section. The quinquennial bonuses in the temperance section have been 17½ times greater than those in the general section, and the accompanying table will show how much less the mortality is in the abstinence than in the general section.

	Abstinence.	General.
Expected deaths	2,002	3,450
Actual	1,433	3,444
Actual number of deaths less than expected	569	6
Percentage of actual less than expected deaths	28·42 (nearly 28½)	·17 (nearly ⅙th).

From a comparison between benefit societies in which the members are not necessarily abstainers, such as Oddfellows and the Wesleyan Friendly Society, with others in which the members are abstainers, it appears that the average rate of sickness for the Colne Wesleyan Friendly Society is 10 days 19 hours, and the average death-rate is 13·9 per thousand, while, for the Rechabites, the average sickness is only 5 days 18 hours, and the average death-rate 9·9 per thousand, giving a gain in favour of total abstinence of 5 days 1 hour per member, and a less death-rate of

4 per thousand. The accompanying table shows comparative results at Bradford.

Bradford District Rechabites.			Bradford District Oddfellows.		
Average Sickness for 8 years: 1870-77	Death-rate.	Payments.	Average Sickness for 8 years.	Death-rate.	Payments.
4 days 2 hours.	1 in 141.	5*s.* 9½*d.*	13 days 10 hours.	1 in 44.	13*s.* 1*d.*

The injury which a man does by indulgence in alcohol is not confined to himself, but descends in some degree to his offspring. The gout which he has acquired by indulgence he transmits to some extent to his descendants, and the children of drunkards are very liable to scrofula and to idiotcy. But worst of all perhaps is the transmission of the craving for alcoholic liquors, by indulging which he has already injured his own constitution.

In the Fourteenth Report of the Inebriate Home at Fort Hamilton, near New York, Dr. Mason gives an analysis of 600 cases of drunkenness treated in the Home. From this it appears that insanity of parents was one of the predisposing causes to drunkenness in the offspring, but the principal predisposing cause was the hereditary transmission of the craving for drink. The proportion of drunken patients having intemperate progenitors was 46 per cent., the father having been a drunkard in 36 per cent. of the cases.[1]

According to Lancereaux,[2] of the morbid tendencies which the drunkard transmits to his offspring, some are purely functional and others organic.

The functional exhibit themselves in excessive sensibility, abnormal reflex excitability, and at a certain age an imperious craving for alcohol.

The organic consist of organic lesions, especially affecting the central nervous system.

Amongst the functional troubles are to be noted hysteria, convulsions, and mental deficiency.

The children of drunkards during the first few years of their lives are often precocious; but if they survive the convulsions or tubercular meningitis which frequently carry them off, they soon

1 Reprint from the *Quarterly Journal of Inebriety*, April 1881, p. 13; *vide* also *British Medical Journal*, Oct. 14, 1882, p. 751.

2 Lancereaux: *De l'Alcoolisme*, Paris, 1878, p. 27.

manifest an arrested development of intelligence, so that when at school they gradually lose the high position they had acquired, and sink lower and lower in their classes. Those who preserve their intellectual faculties are often attacked again by epileptic convulsions at the age of puberty. They generally lack mental equilibrium, and are restless and unsettled. They lack application, their temper is uncertain, and if they have any aptitude for literature or art, it is never of a high order.

The craving for alcoholic liquors which the drunkard transmits to his offspring manifests itself at varying ages. It generally appears when some great physiological change is occurring, as at puberty, and sometimes later during an attack of disease; in females during pregnancy, or at the menopause. According to Dr. Mason, the inebriate tendency manifested itself in five-sixths of the cases treated in the Fort Hamilton Home between the ages of 15 and 35, and in the larger proportion between 15 and 25.

Sometimes, says Lancereaux,[1] youths begin to drink as soon as they leave college, and henceforward manifest a special craving for alcohol, which cannot be the effect of example, as they have been separated from their parents, and must, therefore, be hereditary. It is a mistake to attribute alcoholic tendencies in the children of drunkards to the example shown them, for those who have been removed from the care of their parents are no more free from the tendency than those who have lived with them. Besides, it is not only the children of people who get drunk that become drunkards, but the children of those who are addicted to chronic drinking without ever getting drunk. This unhappy tendency is sometimes continuous, and sometimes intermittent, and frequently co-exists with vicious tendencies which render the unhappy heir to it an idle vagabond, incapable of living in society.

The morbid changes which occur in cases of hereditary alcoholic tendencies consist in inflammatory lesions of the nerve centres, which vary according to the age at which they occur in the fœtus, the child, or adult. During the fœtal condition, the changes are those of arrested development. The most complete is that where the brain is almost entirely absent, as in an encephalous infant, which is born without any brain. Another is that in which atrophy of the brain occurring during fœtal life or early childhood is partial instead of being complete, and affects only one-half of

[1] Lancereaux, *Op. cit.* p. 27.

the organ. Such cases are generally accompanied by a deformity of the head, by epilepsy, and by hemiplegia with atrophy of the paralysed limbs. Sometimes the development of the whole brain is partially, instead of being completely, arrested, and the head is then very small; the individual is idiotic and sometimes paralysed in the lower extremities also. Out of 83 epileptic children or youths examined by M. Martin, 60 were the children of parents given to drink; and in 23 drunkenness was not ascertained. In 60 families to which the patients of the first series belonged the number of children had been 301; but out of those, 132 were dead at the time the observations were made. Out of the 169 surviving, there were 60 epileptics, 48 had had convulsions in early life, and only 64 could be considered as healthy. The 23 cases in the second series belonged to 23 families having 106 children, of which 27 were dead. Of the 79 surviving, 23 were epileptic, 10 had convulsions in early life, and 46 appeared healthy; a great number of these children also were paralytic and badly made. Excess in alcoholic liquors may be reckoned as one of the causes of infantile paralysis, but it is to epilepsy that it specially gives rise.

M. Lancereaux concludes his observations on the effect of alcohol on the progeny of the drunkard by saying that alcoholic liquors, such as are now consumed, pervert the most important and noble faculties of the man who abuses them; they disturb his nutrition; they make him old before his time; nay, more, they affect his progeny, whom they change and often kill. It is fortunate for mankind that, while the descendants of the good continue to enjoy the advantage derived from their forefathers for centuries, "the sins of the fathers are visited upon the children" only "to the third or fourth generation." The unhappy tendencies of the father are transmitted to the children, but a stop is put to the wide degeneration of the race which might otherwise occur by the fact that alcoholism tends to lessen reproduction as well as to increase mortality. Sterility may affect those who have acquired intemperate habits as well as the descendants of such persons, and the children, when born, being very liable to disease, the family is likely to die out.

In order to understand fully the influence of alcohol upon health, however, we must consider not only its direct influence upon the body and the mind of the drunkards and their offspring, but we must take into consideration the effect it has upon their

circumstances. A disproportionate part of their earnings being spent in drink, they are unable to afford for themselves and their families such good food, clothing, and lodging as they might otherwise have. At a certain stage of degradation, the drunkard may be still alive to all his own requirements while regardless of those of his family, and may leave them to be hungry and cold, while he is warm and comfortable at the public-house. But as his drinking habits continue, and years advance, his power of earning is diminished; instead of working the whole week he works only a part of it, and his labour during that time becomes less and less valuable. A few years ago a master-tailor told me that he had sometimes great difficulty in getting orders completed in time, because some of his best men only worked for about half the week. They were paid on Saturday, they were drunk on Sunday and Monday, and ill on Tuesday, and only began to work on Wednesday. Nor is the work so good after a debauch of this sort, although its imperfections may not be so manifest in tailoring as in trades where the work is very delicate, as, for example, in grinding lenses for microscopes. In this process the glass used for making the lenses is fixed in a holder and pressed against a rapidly revolving disc. It requires to be held with the utmost steadiness, and gradually turned in such a manner that it shall be equally ground over the whole surface, as the least inequality greatly diminishes or completely destroys the value of the lens. The quality of the lens can only be ascertained after it has been fitted up so that a test object can be examined through it. A celebrated microscope maker in Paris, while showing me this process, informed me that the lenses made by workmen who were perfectly sober, but had been indulging in liquor the day before, were of greatly less value than those made by them at other times; and where men were at all addicted to intoxication, it did not pay to keep them, as the loss of time in examining the lenses was so great.

As years pass, intemperate workmen become more idle and less able to labour, so that unless they are carried off by disease, they find their way into the workhouse.

There can be no doubt whatever that drinking is a great cause of pauperism, both in the drunkard himself and those dependent upon him. In the "Report by the Committee on Intemperance for the Lower House of Convocation of the Province of Canterbury," the testimony of governors and chaplains of workhouses was to

the effect that between 70 and 80 per cent. of the inmates of workhouses became paupers through drink. But the amount of pauperism does not exactly coincide with the amount of drunkenness. By a comparison of the curves given on the table, Fig. 3, it appears that in those years when an increased amount was spent in alcohol there is rather a diminution in the number of paupers; and this, after all, is what we might expect. For an expenditure in alcohol usually means an increased amount of money to spend, and the same prosperity which fills the public-houses partially empties the workhouses. The increase of pauperism due to drunkenness does not occur at the time when the greatest amount of money is spent in drinking, but some years afterwards. If we compare the curves in the table, we shall see that there is a rise in the curve for alcohol expenditure in the years 1861 and 1866, and a rise in the curve for pauper expenditure in 1863, 1869, and 1872. In 1876, when the expenditure for alcohol is highest, the curve of pauperism is lowest; and then, as the expenditure on drinking diminishes, the expenditure on pauperism increases. Bad years, which give the tippler less money to spend in drink, press hardly on the drunkards, who are readily broken down, and drive them and those dependent upon them to the parish for relief.

Of the relations between crimes and drink it is unnecessary to speak; the accompanying table brings it out more fully than any words could do. From it we see that the curve which indicates the apprehensions for crime of all sorts follows the curve of alcoholic expenditure even more closely than the curve of apprehensions for drunkenness.

From the Thirty-fourth Report of the Commissioners in Lunacy to the Lord Chancellor, ordered by the House of Commons to be printed August 2, 1880, it appears that lunacy has been on the increase during the past ten years, and this in greater proportion than the increase in the population.

That intemperance is a cause of lunacy is generally admitted, but the exact relationship between the two is not altogether decided. Some are inclined to regard lunacy, or at least a tendency to it, as being the primary mischief, and the habits of intoxication as simply an outcome of this tendency. Others again regard intemperance as the cause of lunacy, while they acknowledge that intemperance alone may not produce it in cases where there is no hereditary disposition, or where the action of

alcohol is not greatly aided by other causes, such as severe mental shock. There can be no doubt that a person having an unstable and weak organisation is more likely to fall into habits of intoxication than a man of a stronger nature, as has already been mentioned, and such an organisation, while it may lead to great achievements in literature or art, is, from its instability, liable to

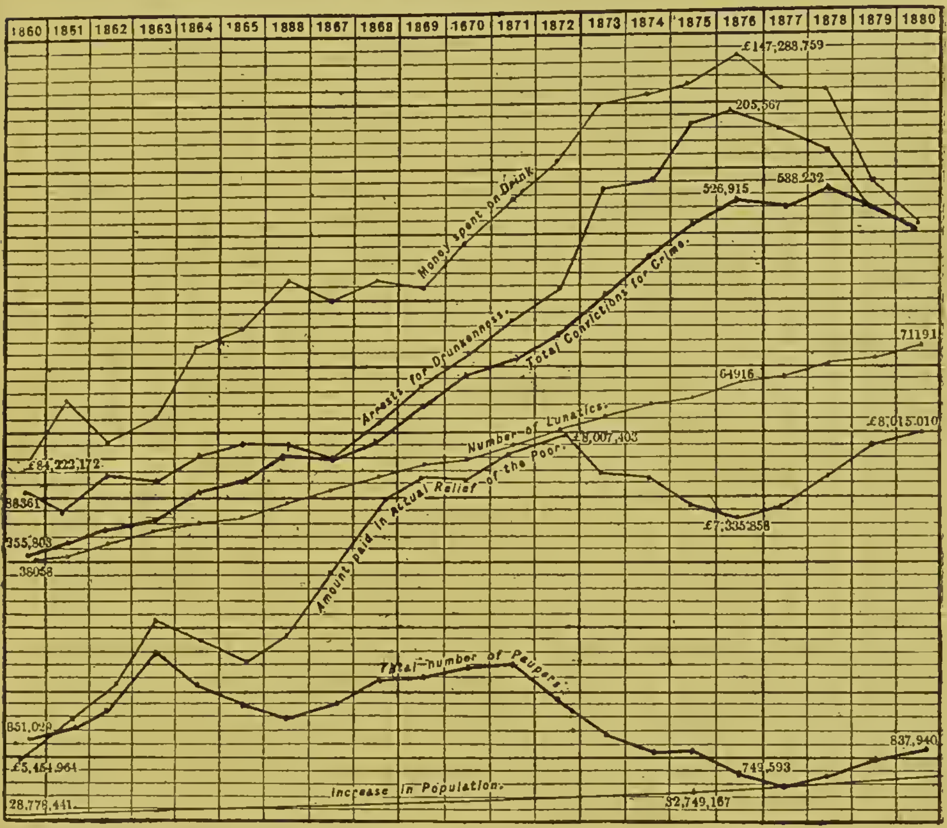


Fig. 3.—Curves representing the Increase in the Amount of Money spent on Drink, Number of Arrests for Drunkenness, Total Convictions for Crime, Number of Lunatics, Amount Paid for Relief of Poor, Number of Paupers, and Population from 1860—1880.

In this figure a different numerical value is given to the vertical divisions in each curve, each division roughly representing 1·20th of the number with which each series begins. In the curve of population, the value of each division is 1,500,000; paupers, 50,000; money paid in relief, £100,000; lunatics, 2,000; total convictions for crime, 10,000; arrests for drunkenness, 5,000: money spent on drink, £200,000.

various aberrations, so that the proverb has arisen that genius and madness are near akin. These aberrations may make themselves manifest in an individual who has at one time shown signs of genius, or at least of talent, or may appear as undoubted madness in another member of the same family. To such persons the attractions of alcohol are usually great, and its effects upon them disastrous. It may, and often does, supply the force needed to

overturn their mental balance and produce well-marked insanity. The insanity in such a case, while evidently due to drink as an exciting cause, might with almost equal fairness be put down to the tendencies of the individual, and probably would be so put down if insanity had appeared without drink in other members of the family. But, on the other hand, according to Lancereaux, a tendency to mental instability is one of the unlucky qualities transmitted by a drunkard to his children; so that while the drunkard himself may escape insanity, the alcohol which he has taken produces a tendency to it in his offspring. Not only may it produce the tendency to insanity, it may and does produce in a large number of cases idiotcy and imbecility in the drunkard's children; and thus alcohol may be looked upon as a direct, as well as a predisposing, cause of insanity. In the Report to Convocation, one superintendent of a lunatic asylum estimated that the proportion in which alcohol acted as a direct and sole exciting cause of lunacy was in one-sixth of the cases, and as an aid to other causes in a much larger proportion. Another considered that directly and indirectly the proportion due to intemperance was about 50 per cent. The proportion of cases admitted into Bethlehem Hospital during 1875–6 in which lunacy was due to intemperance was 6·25 per cent. in males, 5·61 in females; and of 511 cases admitted into the West Riding Asylum, Yorkshire, in one year, 11·35 per cent. were due to alcohol, 1·56 were due to alcohol complicated with habitual tendency to insanity, 2·93 per cent. were caused by excess of alcohol combined with other adverse physical conditions, and 1·95 per cent. were due to alcoholic excess combined with other adverse physical conditions, and 1·95 per cent. were due to alcoholic excess combined with mental causes—a total of 17·79 per cent. of alcoholic cases on the admissions. The total percentage on the male admissions was 31·20, and that on the female admissions only 4·98.

Dr. Bucknill shows by those statistics that the common statements that drink causes from 50 to 80 per cent. of all the mental diseases in this country are considerably overdrawn; yet the conclusion he comes to is, that "drunkenness is the greatest remaining curse of this age and country," and he believes "intemperance in drink to be by far the most potent of all removable causes of mental disease." [1]

[1] *Habitual Drunkenness and Insane Drunkards*, John Horace Bucknill, M.A., F.R.C.P., pp. 85–8.

The curve (Fig. 3) shows that, while there is a distinct relationship between the curves for alcoholic expenditure, amount of crime, and amount of pauperism, no such distinct relation exists between alcoholic expenditure and amount of lunacy. Instead of following the curve of alcoholic expenditure, the curve of lunacy forms rather a slightly undulating line more nearly corresponding to the rise in population; but the rise is much more rapid than that of population, the increase in lunacy from 1865 to 1875 being 67 per cent., while that of the population was only 13 per cent.; and the increase of drunkenness in the same time was 130 per cent.[1]

Before quitting this subject of alcohol, it may perhaps be advisable to give a short *résumé* of its action and place:—

When drunk, it increases the secretion and movements of the stomach and intestines, and thus, in moderate quantity, may aid digestion; but, in some persons, beer and wine, even in moderation, instead of aiding, may retard digestion; and when gastric catarrh is present may interfere with it most seriously, so that, in such cases, alcohol in every form should be carefully avoided.

In acute diseases, it seems to aid digestion rather than to interfere with it, and is, therefore, useful along with food in acute diseases, such as fevers—in convalescence from acute diseases—and in chronic wasting diseases, such as consumption.

It may also be taken in moderation, that is to say, in a quantity not exceeding at the utmost two ounces of absolute alcohol in twenty-four hours, either as a luxury by healthy people, or as a medicine by those whose digestion is below par on account of debility from various causes.

Young and healthy people do not require it, and are better without it.

Its action on the circulation is to increase the force of the beats of the heart, and the rapidity of the circulation. It is, therefore, useful in conditions of great weakness, where failure of the circulation threatens a fatal issue.

It is uncertain whether or not it has any stimulant action on the nerve centres apart from its reflex effect through the nerves of the mouth and stomach, and its stimulant action upon the circulation. Any stimulant action which it may have upon the nerve centres apart from these is slight and transitory, if it exists at all; and its

[1] Third Report on Intemperance before the Select Committee of the House of Commons, 1877, p. 301.

chief action is one of paralysis. The various parts of the nerve centres are paralysed in the order of their development, the highest and latest developed being the first to suffer. The usual order is as follows: first judgment and self-restraint disappear; then the power of perceiving the relations of external circumstances to the organism is lost, and the man becomes foolhardy, ridiculous, stupid, quarrelsome, or maudlin. The cerebellum follows next, and the power of co-ordination is lost; then the spinal cord; and last of all the medulla oblongata and heart. Alcohol reduces a man first to the condition of a child, and then to that of a beast.

By stimulating the circulation, and at the same time producing a childish joyousness, alcohol gives pleasure, and this pleasure, when indulged very moderately, may be productive of no bad effects. It is, however, in those people in whom the pleasure is greatest that the danger of being led into excess is also greatest. Individuals in whom the hereditary craving for alcohol exists, or in whom the hereditary tendency to insanity renders the development of such a craving probable, ought to become total abstainers. It would be indeed advisable that no one, even though free from hereditary tendency to drunkenness, should touch either wine, spirits, or beer before the age of twenty-one.

The different forms of alcohol, spirits, wines, and beers have somewhat different actions, partly on account of their different strength, and partly from the additional ingredients which wines and beers contain. As a rule, the most harm is done by spirits, and least by small beer and weak wines, such as those drunk by the peasantry abroad. Strong ales and strong wines are intermediate between spirits and the weaker wines and beers, and may, like spirits, be productive of considerable harm. The drunkenness caused by spirits is more likely to be furious; that by wine, gay; and that by beer, stupid.

Alcohol does most harm when taken upon an empty stomach, and least when taken with food. Much exercise in the open air lessens its injurious effect. Excess in alcohol diminishes the strength, both physical and moral, of the individual, and tends to shorten his life, to induce insanity, to lead him into poverty and crime; and the mischief he has done to himself he transmits to his children. Besides the privations and temptations to which the children of the drunkard are exposed, they inherit a weakened body, a tendency to convulsions, to idiotcy, and to insanity, or at least an unsettled mental equilibrium, which renders them useless

members of society, flighty, unsteady, and untrustworthy. In addition, they inherit the craving for drink which usually develops itself between the ages of fifteen and twentv-five.

Ether.

Another stimulant, which is sometimes used in place of alcohol, is ether. This is generally employed in manufacturing towns, and sometimes has been used by the population after they have taken the pledge to abstain from alcohol. The effects of ether are in many respects similar to those of alcohol. If differs from it, however, in some respects: it does not cause coagulation of the albumen contained in the blood, nor does it produce the same burning taste in the mouth, or feeling in the stomach. It is a much more powerful stimulant of the digestive secretions and of the movements of the stomach and intestines than alcohol, and might thus, perhaps, be employed with much advantage as a substitute for alcohol in cases of dyspepsia. Its effect on the nervous system resembles that of alcohol, but it is produced more rapidly, and passes off more quickly.

Opium.

Another stimulant, or rather narcotic, which is extensively used is opium. This is the dried juice obtained from poppy-heads. Most of it is grown in Asia Minor and India, though some is obtained also from Persia and Egypt. When the poppies are still green, but nearly full-grown, they contain a thick white juice. At this time men are sent to the poppy-fields, who make a number of deep scratches into the poppy-head, and from each scratch the juice exudes. In about twenty-four hours after, it is scraped off and collected. It is allowed to become dry and thick, and is then made up into lumps. It occurs in several forms, according to the country from which it is brought; some of that grown in Asia Minor and brought to this country, *viâ* Constantinople, occurs in small masses about a quarter of or half-a-pound in weight, and wrapped in a poppy leaf; while that brought from Smyrna is brought in masses from a quarter of a pound to two pounds in weight, and covered with dock-seeds. Some of the East Indian opium comes in flat square cakes, as the Malwah, or garden Patna

opium; but most of it is in round balls, like cannon-shot, or rather shell, about six inches in diameter, and about four pounds in weight. The inside of this consists of a soft, dark mass of opium, with a thick case of poppy leaves, so that in section it somewhat resembles a shell, the dark opium in the centre corresponding to the gunpowder.

Opium contains several active principles. As some of these are chemically related to ammonia, and have like it an alkaline action, they are called alkaloids. But they differ from ammonia in being much more complex in their constitution, and containing a quantity of carbon. The chief alkaloids in opium are morphia, codeia, and thebaia. These are combined with a vegetable acid called meconic acid. The alkaloids contained in opium have different actions; but they may be arranged to a certain extent in a graduated series. At one end of the series stands morphia, which, when given to animals, has the power of producing sleep, but has no marked action in causing convulsions, excepting in frogs. At the other end stands thebaia, which causes convulsions very much like strychnia, and has almost no power of producing sleep. The other alkaloids may be arranged intermediately between these two, all of them possessing a mixture of narcotic and convulsive powers, but in different proportions.

Unlike alcohol, opium has no irritant local action, and thus the effects which alcohol produces reflexly are entirely wanting in its case. The effect it produces is through its action on the circulation and nerve centres after it has been absorbed. It has been questioned whether it has any local action at all; but I think it is difficult to deny that such local action does really exist, for when applied to a painful part it lessens the pain even before it has produced any effect on the body generally. It has also been found that when locally applied to the foot of a frog it lessens the sensibility of the skin. It appears to produce this effect by blunting the sensibility of the sensory nerves of the part to which it is applied. In the mouth it has a somewhat bitter peculiar taste. When put into the cavity of a decayed tooth, it frequently lessens the pain. A good mixture for this purpose is laudanum, with a little bicarbonate of soda, placed upon a pledget of wool.[1] When swallowed it lessens the secretion and movements both of the stomach and intestines; at the same time it diminishes the sensibility, and will remove the sensation of hunger. It is useful in lessening the pain

[1] Duckworth: *Practitioner*, vol. xiv. p. 260.

of colic, or of abdominal inflammation. From the local blunting effect which it exerts on the sensory nerves of the stomach and intestines it tends to prevent vomiting, and to arrest diarrhœa. As its chief effects are produced by its action on the nerve centres, after it has been conveyed to them by the blood, it is evident that its power will depend very much on the rapidity with which it is absorbed. Thus it has happened that during the cold stage of cholera, when absorption from the stomach had almost ceased, large quantities of opium have been given without apparently the least effect; but after the patients began to recover, and absorption again commenced, they died, poisoned by the opium, which had till then remained unabsorbed. It is by this want of absorption also that we may explain the curious instances which we sometimes find of delayed action after opium has been taken. I was once asked at eight o'clock at night to see a lady who was poisoned by opium. She had been suffering from toothache, and at eight o'clock on the previous night she took a dose of laudanum, which appeared to have no effect. An hour or two afterwards she took another dose, which was also apparently without effect, and again a third, which also failed to relieve the pain, and she remained awake all night. About eight o'clock in the morning, however, she fell asleep, slept all day, and the sleep became gradually deeper and deeper, until at eight o'clock on the second night she was in a state of coma. By the use of proper measures she was gradually brought round, and in about four hours appeared out of danger. Here, in all probability, the laudanum had simply remained unabsorbed in the stomach for several hours, giving no relief, and indeed producing no effect until after absorption had begun, when the large amount that had been taken produced symptoms of poisoning.

Another remarkable instance is that of a gentleman of my acquaintance who suffered for awhile from great pain, and had been obliged to take opium for its relief regularly during a period of three months. At first a small dose was sufficient to relieve the pain, and it acted in about a quarter of an hour; but as he became more and more habituated to the drug, he not only required a larger dose, but was obliged to take it a long time beforehand. So much was this the case that towards the end of the period, when he had begun to discontinue the drug, he found that if he wished for a good night's rest he had to take the opium not less than twenty-four hours before.

While absorption of opium is going on from the stomach and intestines, excretion is also taking place by the kidneys. The quantity of opium circulating in the blood at any one time, therefore, amounts simply to the difference between what has been absorbed and what has been excreted. It is evident that if absorption goes on slowly, and excretion goes on rapidly, there may never be enough opium in the blood to produce any perceptible effect upon the nerve centres. Probably this is the explanation of those cases of idiosyncrasy in which persons totally unaccustomed to take opium have been able to swallow without the least effect a dose of opium which would usually prove certainly fatal. A case of this sort is related by Sir Robert Christison, where a gentleman of his acquaintance, not accustomed to the use of opium, took 450 drops of the best laudanum without any other effect than some headache and constipation; and, singularly enough, his son at the age of six years took sixty minims of solution of hydrochlorate of morphia without any apparent effect at all.

It is equally evident that where either absorption is quick or excretion slow, the effect of opium will be disproportionately great. This appears to be the case in persons who suffer from some forms of kidney disease, in whom morphia is apt to produce dangerous results. In children, also, opium produces a disproportionately great effect; so that a single drop of laudanum has been known to kill an infant. This might be partly due to rapid absorption and slow excretion; but this is by no means altogether the case. After its absorption its action will be modified by the condition of the nerve centres themselves, and in the child the mass of the brain is very large in proportion to the body, although it is yet undeveloped in structure.

Opium, when taken in small doses, has but little effect upon the circulation, and in this respect also is unlike alcohol. In moderately large doses it somewhat quickens the heart, and somewhat lowers the tension in the vessels. Like alcohol, it appears to lessen the disturbing influence of surrounding conditions upon the organism. First of all it seems to cause a soothing sensation, and any pain or irritation which may be present usually is diminished or disappears. According to Sir Robert Christison, the nervous excitement it produces may be directed into different channels by the will of the individual. Some years ago a railway accident took place on a dark night, and the cause of it was rather

peculiar. For some reason or another, the engine-driver had been compelled to stop the engine and reverse its action, and on again starting, he turned on steam as usual, but forgot to alter the movement of the engine to a forward one. The consequence was that, instead of going forward, the engine and train ran backwards. From the darkness of the night the engine-driver did not see the direction of the movement, and the engine and train ran backwards instead of forwards for several miles, so that a collision was the consequence. Here the steam had been turned on as usual, but the mechanism upon which it acted had been altered. A somewhat similar condition appears to occur in the human brain under the influence of opium. Thus if the person taking opium yields himself up to its somnolent influence, he falls into a quiet sleep; this generally continues for six or eight hours, and is followed for some hours longer by listlessness, giddiness, and languor; or sometimes also by sickness, loss of appetite, and headache. If he desires rather to enjoy the pleasures of reverie, he may sit down and have a series of pleasant day-dreams for a considerable time; or if he desire to work, his faculties become clear, his ideas brilliant, precise, and uncontrolled, his power of application more intense, his conversation and energies improved, and his muscular movements facilitated. After some hours a stage of drowsiness ensues, as after the hypnotic operation of the drug.

"During the prolonged excitement of the nervous system," says Sir Robert Christison, "it seems probable that the particular manifestations of the excitement are directed partly by constitutional peculiarities, but occasionally by an effort of the will, and thus one man becomes a lively, conversable member of his social circle; another applies with energy to the labour of literary composition; another, in placid indifference to everything around, indulges in a trip to the realms of fancy; and another, turning his mind to the expression of what is passing within him, performs a series of extravagant, irregularly connected acts, transcending in some measure the phenomena of intoxication. These singular varieties in the action of small doses sometimes originate in constitutional peculiarities; but this is probably not so often their real cause as commonly thought. They may be sometimes satisfactorily referred to the effect of an original impulse of volition. I have known most of them to be produced under different circumstances in the same individual." [1]

[1] Christison: *Dispensatory*, p. 682.

De Quincey thus describes the effect which opium produced upon him when he first took it for the relief of pain :—

"But I took it, and in an hour, O heavens! what a revulsion! what an up-heaving, from its lowest depths, of the inner spirit! What an apocalypse of the world within me! That my pains had vanished was now a trifle in my eyes. This *negative* effect was swallowed up in the immensity of those positive effects which had opened before me—in the abyss of divine enjoyment thus suddenly revealed. Here was a panacea—a φάρμακον νηπενθές—for all human woes. Here was the secret of happiness about which philosophers had disputed for so many ages at once discovered! Happiness might now be bought for a penny, and carried in the waistcoat-pocket; portable ecstasies might be had corked up in a pint-bottle; and peace of mind could be sent down in gallons by the mail-coach."

The after effects, even of a small dose of opium, when the primary sleep or excitement has passed away, are nausea, headache and depression. These are best relieved by lemon-juice and strong coffee. They also disappear under the influence of a renewed dose of the drug; but when opium is taken continuously it gradually loses its power, and the dose requires to be increased. The quantity which opium-eaters will take is sometimes enormous. De Quincey, the English opium-eater, at last took nine ounces of laudanum, which is equal to 333 grains of solid opium, daily. Mr. W. E. Image, of Bury St. Edmunds, observed two cases in which no less than sixteen ounces of laudanum per diem were taken.

As the habit becomes confirmed, the excitement diminishes, and the miserable after effects become more marked. So much is this the case that after a time the habit is continued rather for the purpose of avoiding extreme misery than for obtaining positive pleasure. So long as opium is taken only in moderation it seems, like alcohol, to be perfectly well borne, and to produce no injurious effects, even when continued for years together; but when taken in excess it destroys the digestion, greatly impairs the nutrition, and ruins the nervous system. Like alcohol it lessens or destroys the power of volition, so that the unhappy victim becomes a complete slave to the habit, and he has no power to throw off its yoke. The resemblance between this condition will be readily seen by comparing the account given by Coleridge[1] of his inability

[1] Cottle: *Early Recollections*, vol. ii. p. 185.

to shake off the habit of opium eating with the account given by Mr. J. Vine Hall of his inability to throw off the habit of alcoholic indulgence.

Yet notwithstanding the apparent powerlessness of both Coleridge and Hall to throw off the ensnaring toils of opium and alcohol, they both of them after many struggles succeeded.

Another method of taking opium is to smoke it instead of swallowing it: this is the plan generally adopted in China. It seems curious that opium while smoked should produce such effects, because the active ingredients which it contains are not volatile. The subject has not yet been thoroughly investigated, but it seems not improbable that the substances actually taken into the body are not those which are contained in the opium, but others nearly allied to them and having a similar action. These are produced from the opium by the heat of the pipe which is employed, in the same way as pyridine and other substances are produced from tobacco during smoking.

In moderation opium smoking, like opium eating and alcohol, does not seem to interfere with, but rather to assist labour, mental and bodily. In the evidence given by Mr. Cooper before the Committee on Indian Finance in 1871, he states that his chair coolies carried him twenty miles a day, and were strong and enduring as long as they got their daily supply of opium, but they became wretchedly weak and miserable after a single day's abstinence, when they would lie down with water streaming from their eyes, listless, disinclined to eat, and unable to sleep.

Mr. T. Evans informs me that the Lascar sailors in the Peninsular and Oriental steamers work hard and steadily while they have their daily supply of opium, but should the voyage last longer than they anticipated, and their supply of opium run short, they become listless, languid, and miserable, and unable to work; while in some a condition of frenzy occurs.

In moderation opium does not seem to impair the intellectual powers, and Chinese merchants, who are certainly sharp and clear-headed enough in their business, will smoke opium regularly.

It is a question difficult to solve whether or not opium is worse than alcohol. It certainly does not seem to lead to so much crime; its effect when taken in moderation appears certainly to be no more injurious to the system. The chief disadvantage seems to be that the taste for opium gains, if possible, a firmer hold upon its victim than the taste for alcohol, and that there is

a greater tendency to immoderate indulgence on account of the ease with which the system becomes accustomed to the drug and the consequent necessity for an increase in the dose.

The effect of morphia is much the same as that of opium, either when taken internally or when taken by injection under the skin. According to Dr. Levenstein, who has particularly studied this subject, after its use there is a condition of mental excitement. The temperature is altered, depressed persons become lively, to the fainting it imparts strength, to the weakly it restores energy, the taciturn become eloquent, shy persons lose their bashfulness, and the consciousness of power and ability is greatly increased. But after these effects have passed off, reaction sets in, and a condition of deep despondency ensues. For the relief of this depression the patient either takes a fresh dose of morphia, or has recourse to alcohol. The evil results arising from the abuse of morphia generally begin to show themselves in from four to six months, but sometimes only after some years; this depends upon the individual constitution, and not upon the dose. Just as in the case of opium, many persons feel quite well while using morphia, but after a time the nervous system and the nutrition become affected, the skin becomes less elastic, the face pale and the body thin, the perspiration excessive, the eyes are listless, the pupils generally contracted, and vision frequently impaired. There is dryness of the mouth, thirst, loss of appetite, nausea and vomiting, the bowels are generally confined, the pulse is usually very small, there is dyspnœa and palpitation, loss of sleep, irritability of temper, hallucinations, disturbances of sensation, as hyperæsthesia, and anæsthesia, trembling of the hands, and depressed reflex action. In some cases albuminuria is present, and the urine generally reduces an alkaline solution of sulphate of copper, but does not precipitate it; it also generally rotates polarised light to the left.[1]

The use of morphia, however, is not incompatible with a high degree of intellectual power, for Dr. Levenstein mentions that he knows a number of persons who suffer greatly from the craving for morphia, and who have yet risen to and still hold their place in the foremost ranks of science and art. Authorities in military matters, artists, physicians, surgeons, bearing names of the highest reputation, are subject to this craving, without the least detriment

[1] *Morbid Craving for Morphia*, by Edward Levenstein.

to their capacities; and some also may retain the highest admiration of their fellows to the very last.

The progress of the craving is generally slow and fluctuating; some are able to take large doses for many years without any symptoms, whilst small quantities will bring on the most severe symptoms in others in a few months. There are frequent intermissions, during which the morbid symptoms begin to disappear, notwithstanding that the use of morphia is continued, though usually in smaller doses. The improvement usually lasts, however, only for a few months, when the dose is again increased, and the symptoms reappear and become aggravated. If no cure is effected, the ultimate result is prostration, emaciation, and death. When people have once suffered from the craving there is always danger of a relapse, and this is still greater if there is a craving for alcohol as well. Once cured, they must never have morphia again, as a single injection administered to such a person is sufficient to vanquish the power of resistance against the craving which has been successfully kept up for months together.

In treating such persons, according to Dr. Levenstein, it is best to deprive them at once and completely of morphia, instead of gradually withdrawing it; and to ensure success the patient should be kept entirely apart under the constant care of nurses, and in a room from which everything by which suicide can be committed has been carefully removed. The strength must be kept up by careful feeding, although for the first few days fluid food only is to be given, and wine or alcohol according as it is necessary. Headache is relieved by cold, pains in other parts of the body by poultices, nausea by ice, sleeplessness by warm baths. When dangerous collapse comes on it may be necessary to give half a grain of morphia subcutaneously. After the morphia has been completely withdrawn for three or four weeks, the patient may be sent to a mountainous district, to the south of Europe, or to a cold-water cure, according to his strength and the season of the year.

Chloral.

Another narcotic which is now very much used is chloral. This substance was first introduced by Dr. Oscar Liebreich. It is split up on the addition of alkalies into chloroform and formic acid, and

Liebreich supposed that when absorbed into the blood, it would become decomposed in this way and slowly liberate chloroform; he thus expected to obtain anæsthesia lasting over a considerable length of time. His expectations were to some extent realised, although it appears that chloral is not decomposed in the blood as he thought it would be. It appears to act in virtue of its own peculiar properties, and causes in man and animals sleep, which is at first quite natural, and from which a person can be readily awakened; in larger doses the sleep becomes deeper, and the person is awakened with great difficulty; in larger doses still it produces complete anæsthesia, and a sleep from which a person cannot be aroused. It is frequently used as an anæsthetic for animals, but it cannot be employed for this purpose in man without great risk. The sleep caused by chloral differs considerably from that of opium in several respects. Chloral does not appear to have the same power as opium to relieve pain, although it will do so when given in large doses; but the sleep that it produces is more natural, and it is not followed by the same disagreeable after effects as opium, the person who is taking it awaking bright and clear-headed, just as from natural sleep, instead of suffering from headache, loss of appetite, nausea, and sickness, as after opium.

On this account chloral has been of late years very widely used by persons suffering from sleeplessness and nervous irritability, and is taken by many people not by the advice of a medical man, but of their own accord. They often continue to do this for a considerable length of time, and think that because there is no immediate disagreeable result the use of the drug is free from danger of any sort. This is not the case, however, for chloral is exceedingly dangerous, both from its power of causing rapid death when taken in an overdose, and from its destructive effects on the nervous system when taken in small doses for a long time together. The symptoms it produces, when taken in an overdose, are deep sleep, passing into perfect unconsciousness, from which the person cannot be awakened: the breathing and pulse become weaker and weaker, and the patient dies.

Professor Stricker and I have found that the deadly effects of chloral can be to a great extent counteracted by means of heat. In cases of chloral poisoning, then, it is most important to keep the patient warm, as well as to employ the measures usual in the treatment of poisoning. The symptoms produced by chronic poisoning with chloral present several forms: some of these are

connected with the skin, others with the mucous membranes, others with the respiration, others with the blood, and yet others with the nervous system.

In the skin, chloral produces a tendency to eruptions of various kinds; these take the form of simple diffused redness, or erythema, more particularly marked about the head and face. It may be constantly present, but in some persons it only occurs temporarily, and whenever anything is taken to stimulate the vascular system.

In such persons very small quantities of wine or beer produce a deep red colour on the face and neck, lasting for an hour or more; and sometimes the eruption extends over the whole body, and may last for a day or two. Instead of simple erythema a papular rash may appear, and sometimes a well-marked nettle-rash is produced.

A condition of the mucous membrane similar to that of the skin may occur as a consequence of the use of chloral: thus in some the conjunctiva becomes red and swollen, and the eyes run; in others there is sore throat and pain on swallowing. The respiration may become very seriously affected, the patient suffering from severe dyspnœa, with occasional cessation of breathing. At first this may simply be felt on going up-stairs, especially after meals; but when the drug is continued, it may increase to such an alarming extent as to threaten death.

The blood appears in some to undergo changes which give rise to symptoms resembling those of scurvy or even of blood-poisoning; not only is the skin red, but in patches it becomes livid; the gums are spongy, the mouth and tongue blistered and ulcerated, and the breathing affected. To these symptoms succeed prostration, drowsiness, difficulty of breathing, and death. In some instances the occurrence of the red rash in the skin is accompanied by a high fever, with desquamation of the skin, watery discharge from the mucous membrane of the intestine and bronchi, and in the formation of abscesses in various parts of the body: a condition which strongly resembles that of blood-poisoning.

In other cases the nervous system seems to suffer most, and the mental qualities are diminished, and sometimes are so greatly affected as to render the person almost idiotic. The powers of sight in some are weakened, and the muscles of the throat are sometimes so much affected that it is almost impossible to swallow. Paralysis of the lower extremities, with diminished sensibility, has also been observed as a consequence of chloral. In others a condition almost exactly resembling delirium tremens has been

said to occur when it was discontinued, after being used for a length of time.

Indian Hemp.

Indian hemp is a narcotic little used in this country, but employed to a considerable extent in the East. It consists of the flowering tops of the common hemp grown in India. This plant when grown in cold countries such as our own has little or no intoxicating power, but when grown in the warm districts of India, a resinous exudation is secreted by the leaves and flowering tops, and to this resin the intoxicating powers seem to be due.

Several preparations of it are employed, and it is known under different names. The flowering tops, gathered before the seeds become ripe and dry, are known by the names of *haschisch* and *gunjah*, the former being the Arabic, and the latter the Indian term. A coarse and cheap preparation, consisting of the larger leaves and capsules, is known by the name *bhang*, and is used by the poorer classes. The resin itself, rubbed off from the leaves, and with a small proportion of the leaf tissue remaining in it, is known by the name of *churrus*. This is often mixed with other substances to render it more pleasant to the senses, and to increase its power, such as otto of roses, musk, cantharides. The *churrus* is said to be collected in Central India by a man clad entirely in leather, walking through and through the hemp-fields, and then scraping off from his clothing the resin which adheres to it as the tops of the plant brush against him during his peregrinations. Haschisch is usually said to produce most delicious dreams, which Dumas has described in the account of Monte Cristo. The name of assassin is derived from haschisch, because the chief of the assassins was said to initiate each member into the mysteries of the society by intoxicating him with haschisch, and then conveying him into a garden, where he enjoyed all the sensual delights of the Mohammedan paradise. After a while he was again intoxicated and removed back to his ordinary conditions of life. Confident that his chief possessed the power of conveying him again to paradise at his death, he was willing to run any risk, or endure any suffering, in the execution of his orders. Under the influence of haschisch, the Malays seem to become insane, and run "amuck," as it is termed, rushing madly along and stabbing every one who

comes in their way. It generally seems to excite a tendency to laughter, but most observers belonging to Western nations have found its effects rather disagreeable than pleasant. The flow of ideas seems to be very greatly quickened, while the individual loses all power of directing them. There is a feeling of great prolongation of time, so that a minute seems hours, and occasionally there is a curious condition of double consciousness. In some persons the power of motion is a good deal lessened, and occasionally convulsions have been noticed. Catalepsy is also said to occur among the Hindoos.

Haschisch differs from opium in leaving very little after effect, the person usually awaking from the heavy sleep into which he usually falls, after the delirium has lasted for a while, without any nausea or sickness as after opium, but rather with a good appetite.

Tobacco.

Tobacco is another narcotic in most extensive use. The tobacco plant, *Nicotiana tabacum*, belongs to the natural order *Atropacea*. It contains an alkaloid called nicotine, or nicotia, combined with a vegetable acid. It differs from most other alkaloids in being liquid instead of crystalline, and in containing no oxygen, being composed of carbon, nitrogen, and hydrogen only. The pure alkaloid is a most intense poison. After a drop or two of the liquid has been taken, the person becomes almost immediately unconscious, with a wild look, and dies, with a deep sigh, in less than five minutes. When given to animals, a single drop will kill a cat or rabbit in two or three minutes, but usually causes convulsions which have not been noticed in man. Tobacco itself, when swallowed, will also cause death, as in the following case from the "Naval Medical Reports":—

"A sailor boy had been frequently punished for chewing tobacco, and had often complained of debility, giddiness, and faintness, which were traced to the poisonous effects of this substance. On two occasions he had swallowed a piece to avoid detection. On the night of his death he went to his hammock, telling his messmates that he felt sick. About ten minutes afterwards the occupant of the next hammock heard him breathe stertorously, and immediately tried to awaken him. He could not succeed, and

when the surgeon came he was found to be moribund. The pupils were insensible to the influence of light, and the pulse, which was scarcely perceptible, in three minutes ceased to beat. On a post-mortem examination two small pieces of tobacco were found in the stomach."[1]

Poisoning also sometimes occurs from absorption through the skin, as appears from the following instance :—

"Dr. Namias relates an instance of a smuggler being poisoned by reason of his having covered his skin with tobacco-leaves, with a view of defrauding the Revenue. The leaves, moistened by perspiration, produced all the effects of poisoning. The pulse was small and feeble; there was faintness, attended with cold sweats. The operation of the poison seemed to be principally on the heart."[2]

It has been found that the heart is the organ chiefly affected by tobacco. The effect is a peculiar one, for it first stimulates and then paralyses those fibres in the vagus nerve whose office is to regulate the beats of the heart and prevent it from going too quickly. These fibres are generally known as the inhibitory nerves. In consequence of this action, the heart's beats become very slow at first, and afterwards very rapid. Just at the time when these inhibitory nerves are beginning to lose their power, we may find alternate quick and slow beats of the heart. This condition may not only occur in animals poisoned by tobacco, but it may be observed in men. Some years ago I was resident physician in the Royal Infirmary at Edinburgh, and I had frequent opportunities for observing this condition. I have not seen it at all so frequently in other parts of the country, and I am inclined to think that it was due to the fact that a number of poor people living in the neighbourhood of the Infirmary were accustomed to use very coarse and strong tobacco in large quantities. The beats of the heart, instead of being regular, had a rhythm which reminded one of a restive horse, breaking off into gallop for a few yards, and then being suddenly pulled up, and then breaking off again. This condition was usually known in the Infirmary by the name of "smoker's heart." It disappears when the use of tobacco is left off entirely, but is apt to return when its use is again resumed. When once it is fairly established, also, it seems that a very small quantity of tobacco is sufficient to maintain this abnormal condi-

[1] *British Medical Journal*, November 1873, p. 520.
[2] Taylor, *On Poisons*, p. 805.

tion, so that it is not sufficient to diminish the quantity of tobacco used; complete abstinence must be enforced in order to effect a cure.

The chief ways of using tobacco are chewing, snuffing, or smoking. In chewing, the piece of tobacco is kept in the mouth, turned about, and masticated, the juice being expectorated. The chief effect of the tobacco thus employed is a local one, consisting in the stimulus which it produces on the sensory nerves of the mouth, and the reflex action which it exerts upon the salivary glands, and probably, also, on the circulation, not only to these glands but to the brain. Absorption from the mucous membrane of the mouth does not take place nearly so readily as from the stomach, and thus the amount of nicotine actually absorbed will be

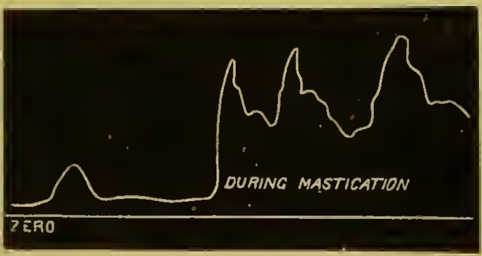


Fig. 4.—Diagram showing the Increase in the Rapidity of the Blood-stream through the Carotid Artery to the Head under the Influence of the Movements of Mastication.

The height of the curve above the zero line indicates the rapidity. The first part of the tracing was taken before, and the latter part while the animal was eating.

not only small in itself, but its introduction into the body will be slow, so that more time is allowed for its elimination. We have already mentioned that active circulation is generally associated with pleasure, and that the various organs of the body during functional activity have the circulation increased. This has been very clearly observed in the case of the salivary glands, a stimulus applied to the tongue or mucous membrane of the mouth producing reflexly in them, not only a secretion of saliva, but such an accelerated flow of blood through them that when the vein which returns the blood from them is wounded, the blood gushes out from it in jets, as if from an artery, instead of trickling slowly, drop by drop, as it would do when the gland is inactive. When the brain is active, the circulation in it also is greatly increased, and such an increase in the circulation will be produced by an irritation of the nerves of special sense. By observations made directly upon the

brain, it has been found that an unexpected sound, for example, increases the amount of blood in the organ, and usually this is accompanied by a contraction of the vessels in other parts of the body; so that the increase in the quantity of blood going to the brain is compensated by a diminution in the quantity going to other parts of the body. The contraction of the vessels in other parts of the body also tends actually to drive blood into the brain. In the opinion of Professor Mosso, who has made some very remarkable observations on this subject, the readiness with which the supply of blood is increased in the brain by any sensory stimulus is one of those arrangements which may be traced to the survival of the fittest in the struggle for existence. This arrangement serves the purpose of increasing the supply of blood to the brain. The readiness with which the supply of blood to the brain may be increased induces a corresponding readiness in the development of energy; it thus enables an animal, at a slight warning sound or touch, to spring up from deep sleep thoroughly awake and active, so that it escapes the dangers to which it would be otherwise liable. It also gives the animal a better chance in a struggle, inasmuch as the one which can bring most energy to bear in a short time may overcome an animal stronger than itself on the average, but which cannot put forth so much energy at once. Although experimental observations on the direct effect of irritation of the fifth nerve upon circulation in the brain are not so complete as one could wish, we know that stimulation of its branches by mastication will greatly quicken the flow of blood through the large arteries which supply the brain with blood, for it is almost certain that the great increase in flow of blood towards the brain, which is shown by the accompanying tracing of Professor Marey's, is due to the nervous stimulus, and not to the mere movements of mastication. Besides this, we know that the branches of the fifth nerve are closely connected with the nervous mechanism which regulates the circulation in other parts of the body. Irritation of its branches usually increases the pressure of the blood in the vessels. The fifth nerve is distributed to the skin of the head and face, to the teeth, the mucous membrane of the tongue and mouth, and to the mucous membrane lining of the nose. Irritation of the nasal branches greatly increases the blood pressure, and it is this power which renders the application of ammonia or aromatic vinegar to the nose so useful in cases of fainting. In an experiment on this subject I found that, in an animal suffering from shock,

the ammonia raised the blood pressure by one quarter of the whole.

It is an almost universal habit among people who are puzzled, to stimulate one branch or another of the fifth nerve by rubbing or touching it. Many people, when puzzled, rub or scratch their heads, or stroke their beard. Germans not unfrequently strike the side of their nose with the finger.

In all these ways a branch of the fifth nerve is stimulated, and probably the cranial circulation is increased. The pleasurable sensations from chewing tobacco are probably dependent to a considerable extent on the local stimulant effect exercised by the weed on the nerves of the tongue and mouth, perhaps even more so than on the general action of the drug in raising the blood pressure. When tobacco is used as snuff, it powerfully stimulates the nasal branches of the fifth nerve, and will probably affect the cranial circulation in somewhat the same way, though more powerfully than smoking. When tobacco is smoked, it has a double action. It stimulates locally the nerves of the tongue and mouth, and in those persons who are accustomed to draw the smoke not only into the mouth, but into the lungs, and expel it through the nose, it stimulates the nerves of the nose and lungs in addition to those of the mouth. It has, besides this, a marked effect on the circulation generally. I have noticed in a friend of mine, a distinguished physiologist and physician, that when trying to solve a difficult point, he is accustomed to light a cigarette and smoke for a minute or two, until the difficulty is solved, after which he at once throws the cigarette aside; sometimes a few whiffs are sufficient, so that it seems very unlikely that sufficient absorption of any of the constituents of smoke has taken place to produce a general effect.

The effects of tobacco when smoked are not, however, to be entirely attributed to the nicotine which it contains, although it is probable that they are partly due to it. During smoking, the tobacco itself and the nicotine are exposed to considerable heat, and are to a considerable extent decomposed. It is the products of their decomposition, rather than the nicotine, which are actually inhaled, and which produce the characteristic effects. The substances which are produced by the dry distillation which the tobacco undergoes in the process of smoking are chiefly the volatile alkaloids pyridine, picoline, and collidine, with other bases nearly resembling them in character. These bases greatly resemble

nicotine both in smell and in physiological action, producing, like nicotine, contraction of the pupil, difficulty of breathing, general convulsions, and death.[1]

Smoking, like snuffing, is sometimes used to quicken the mental faculties, or to "clear the head," as it is termed; and here it is almost certainly the reflex effect of its local action on the mouth and tongue which is produced.

When used for the mere purpose of enjoyment, and not as a stimulus to work, the effect produced by tobacco smoking is rather difficult to analyse. It seems to have a soothing effect, and to give an undefined feeling of pleasure, and when used in moderation may be continued for a long time without exercising any injurious effects whatever. When carried to excess, and generally when it is used for the first time, it produces intense sickness and depression, muscular weakness, and feeble pulse. The same symptoms which occur on its first use may be brought on by over-indulgence, even in those accustomed to it, and occur more especially when they use a stronger tobacco than usual. Death even may arise from tobacco smoking.[2]

The peculiar affection of the heart which it produces has already been noticed. Sometimes also it produces sudden fainting, which comes on without any warning. Occasionally there may be no apparent exciting cause; sometimes, however, emotional excitement aids the tobacco in producing the faint. As an instance of the first kind, a friend of mine told me that a young gentleman was one day dining at his house, and just as he was taking leave of his hostess, he fell suddenly insensible on the drawing-room floor. Another gentleman told me that while going some time ago to see a friend, he fell down suddenly insensible in the street. In his case slight emotional excitement had combined with the tobacco to produce the fainting. My friend, Professor T. R. Fraser, of Edinburgh, also informs me that almost all his college friends who had been accustomed to smoke to a considerable extent as students have been obliged to give up the use of tobacco as middle age approached, and that several of them have done so on account of being seized with fainting fits such as those I have described.

But besides these alarming effects of excessive tobacco smoking, there are others which are less serious. One is an irritable con-

[1] Vohl and Eulenburg, *Arch. Pharm.* [2], cxlvii. pp. 130—166.

[2] Taylor, *On Poisons*, p. 806.

dition of the throat leading to hawking and spitting. Another is a condition of persistent dyspepsia. Another is an affection of the eyesight, which is thus described by Mr. Macnamara in his work on "Eye Diseases": "The patient usually finds that his sight has become somewhat suddenly enfeebled. The acuteness of vision is sensibly diminished, the patients, perhaps, being scarcely able to read numbers 8 or 10 test types, while in some cases they cannot distinguish even the largest type. A sort of white haze seems to envelop every object, and improvement generally takes place towards evening or on dull days, the haze being then less apparent. The perversion of the chromatic faculty is marked. Yellow, red, and green are often confounded with each other. These patients often see double or triple, probably on account of spasmodic contractions of the muscles of the eye. The pupils are not unlike in the two eyes, one being generally larger than the other and often irregular. No other alteration is observed in the exterior of the eyes. Ophthalmoscopic examination in early stages of this affection often demonstrates serous suffusion, especially in the vicinity of the vessels. The arteries in some places exhibit spasmodic contractions, while the veins are tortuous and gorged. This disposition is observed to be more marked as the disease becomes prolonged, and then the papilla of the optic nerve is pale and whitened. De Wecker, however, states that he has never seen general pallor of the disc tending to atrophy in these cases.

"From the above statement of symptoms it appears that tobacco and alcoholic amblyopia is an affection of the eye apart from atrophy of the papilla from other causes, such as neuritis or tabes. Tobacco amaurosis may even be completely cured, to return again after renewed excesses in drinking and smoking."

According to Galezowski, it is "due to paresis of the longitudinal dilating fibres of vessels, or spasmodic contraction of their circular fibres. The blood does not arrive in a sufficient quantity by the arteries, while the veins undergo a kind of passive stasis. The disease is a consequence of prolonged indulgence in tobacco and alcohol, especially when the latter is taken fasting or before dinner. Bad food and misery predispose. Complete abstinence from alcoholic drinks and tobacco for weeks or months is indispensable. The best treatment is bromide of potassium internally, and eserine lotion externally."

It is tractable at first, but afterwards it cannot be relieved.

The effect of tobacco is modified not only by the extent and

way in which it is employed, but by the kind used. The strongest tobacco which is prepared for chewing contains only a mere trace of nicotine, and others contain none at all. That used for snuff also contains but a small proportion; the greatest amount is contained in the tobacco used for cigars.

In preparing tobacco which is to be converted into snuff, the dry leaves are moistened with water and made into heaps, and allowed to heat and ferment for some months. During the fermentation, a decomposition takes place in them: nicotine and ammonia are given off, so that they lose to a great extent their poisonous properties. They are afterwards again moistened with salt and water and allowed to ferment in close boxes, when their odour and pungency become developed. When tobacco is smoked, it is not the nicotine actually contained in the leaf which chiefly produces the effect upon the smoker, but the volatile alkaloids formed during the combustion of the tobacco. These alkaloids differ according to the mode in which it is smoked, and this appears to be the explanation of the well-known fact that very much stronger tobacco can be smoked in the form of a cigar than in a pipe. Indeed, if a smoker cuts up a cigar which he could smoke with pleasure into small pieces, and smokes it in a pipe, it is very likely to make him sick. According to Vohl and Eulenburg, the tobacco which is smoked in a pipe yields a very much larger proportion of volatile bases, and especially a large quantity of the very volatile and stupefying pyridine; while in a cigar little pyridine and much collidine is formed, the latter being less volatile and active than pyridine. The observations of Vohl and Eulenburg explain how it is that when tobacco cannot be had, other substances when smoked may produce a similar, though less agreeable, effect. They found that dandelion, willow-wood, stramonium, and even bogwood coal yielded, on dry distillation in a pipe, bases very much resembling, though rather weaker than, those produced by tobacco. They also think that the action of opium when smoked is not due to the alkaloids it naturally contains and which are not volatile, but to the products of their dry distillation. The effects of opium smoking no doubt differ to some extent from tobacco smoke, but this difference is probably due simply to different alkaloids being produced by the dry distillation in the processes of smoking from opium and tobacco.

But though dried leaves and dry wood when smoked yield bases which have somewhat the same physiological effect as tobacco,

there is this great difference between them: that the taste of the smoke is not nearly so pleasant, and so men only smoke these substitutes when they are driven to do so by necessity. It is indeed quite extraordinary how the taste of the smoke is affected by slight differences in the condition of the substances used. Thus, it is well known in Europe that pigs' dung, when used to manure the tobacco plant, gives a peculiar flavour to the tobacco raised, and it is said that the Maronites of Mount Lebanon readily recognise the variety of manure employed in the cultivation of their tobacco by its flavour; thus, in those parts, that tobacco is held in highest esteem which has been manured by the droppings of the goat.

One great objection which is often raised to the use of tobacco is, that it leads to drunkenness. Tobacco, it is said, excites thirst; the thirst must be quenched with beer, or spirits and water; and hence the man who begins to smoke is led on to drink. There can be no doubt that in some persons the use of tobacco by smoking does produce thirst. This depends partly on individual constitution, and partly on the mode in which the tobacco is smoked. In some persons, smoking causes a profuse flow of saliva, so that they are obliged constantly either to swallow it or to expectorate it, and I am inclined to think that it is in such people that smoking chiefly excites thirst. In others, smoking seems to cause but little flow of saliva, so that they have no need to expectorate. Even those persons who are obliged to expectorate by smoking a pipe are not affected to the same extent, if at all, by smoking cigars, and where the smoke is drawn through water, as in a narghilé, or hookah, probably no thirst whatever is produced.

In countries where these forms of pipe are used, thirst is a thing much to be dreaded; yet I have seen Arabs after walking up a toilsome ascent, under a hot sun, stop for awhile in the middle of the day and light their narghilés. This they would hardly have done if it had any tendency whatever to produce thirst, as they had still a considerable distance to march before their day's journey was over. Probably this difference in the way of smoking is the reason why, both in this country and in New England, tobacco has been accused—and not altogether unjustly—of leading to drinking; whilst travellers in the East say, on the contrary, that it tends to produce sobriety. Mr. Lane, the translator of the *Arabian Nights*, says that "being in a slight degree exhilarating, and at the same time soothing and unattended by

the injurious effects which proceed from wine, it is a sufficient luxury to many, merely to pass away hours of idleness." Sir Austin Henry Layard, whose intercourse with Eastern nations has been still more extensive, entertains the same opinion; while Mr. Crawford, who quotes these opinions, and has also seen much of Eastern life, "thinks it can hardly be doubted that tobacco must, to a certain extent, have contributed to the sobriety of both Asiatic and European nations." [1]

In England and New England tobacco is smoked chiefly in pipes, and especially in short pipes, so that a much larger quantity of the volatile products of combustion, or tobacco juice, reach the mouth than when it is smoked in other ways. This tobacco juice is exceedingly poisonous: "one drop applied to the tongue of a cat brought on convulsions, and in two minutes occasioned death. The Hottentots are said to kill snakes by putting a drop of it on their tongues. Under its influence the reptiles die as instantaneously as if killed by an electric shock. It appears to act nearly in the same way as prussic acid. The natives of Cambambe, on the West Coast of Africa, poison the chameleon in a few seconds by drawing a straw dipped in the 'oil of pipes' across the poor creature's tongue and mouth." [2] When the narghilé is used, the whole of this oil is retained by the water through which the smoke passes; and in the very long pipe used in Germany, the oil falls into a reservoir and does not pass into the mouth. Another objection to the short pipe is, that it is said to lead to cancer of the lip, and there is no doubt that the constant irritation of the pipe resting against the lip has this effect in persons who are predisposed to it; without the predisposition it would not occur, for many persons go on smoking short pipes all their lives without getting it; but, on the other hand, it is probable that the predisposition alone might be insufficient to produce it without the local irritation.

Betel-nut.

The betel-nut is the fruit of a species of palm, the *Areca catechu*, which is found in India and in many other parts of Asia. It is chewed by the natives apparently for the same purpose as tobacco in this country, because it affords pleasure of some sort. The

[1] Crawford: *Journal of the Statistical Society*, March 1853, p. 52.
[2] *Chemistry of Common Life*, p. 284.

betel-nut, unlike tobacco, contains no substance having any marked physiological action on the body. Its chief constituents are a kind of tannic acid, which, with alkalies, yields a red colour. It is either softened by boiling it in water, or used when quite young and soft; it is cut into small pieces and rolled up with some lime in a leaf of the betel pepper. When it is then chewed it gives a red colour to the saliva and to the lips and tongue; but it is sometimes stated that the betel-nut is chewed for the purpose of producing this red colour of the lips, but this can hardly be the case. Its action is indeed very difficult to explain, unless we believe that it causes a free flow of blood through the brain by stimulating the mouth in the way already described when speaking of tobacco. On this view, however, its action becomes at once easy to understand, and its stimulant effects are readily intelligible, even although it contains nothing which acts on the heart, vessels, or brain directly.

Tea.

In almost every part of the world we find that hot infusions of the leaves of various plants are used as beverages; but the most important by far of all these is China tea, or simply tea; the other varieties of tea being distinguished by some appellation derived from the name of the plant used, or the district in which it is employed.

Tea consists of the dried leaves of a kind of camellia—the *Camellia thea*, sometimes called *Thea Chinensis*. It is probably a native of Assam; but it is now grown in immense quantities in India, China, Japan, Java and the Southern United States. There are several varieties of it, which were formerly looked upon as different species. The name tea is from the Chinese *têh*. It was formerly supposed that the black and green teas were produced by distinct species of plants, but this is not the case. The difference is due to the mode of preparation. The commercial sorts of black teas are, Congou, Souchong, Oolong, Pekoe, and Caper; and of green teas, Hyson, Hyson Skin, Young Hyson, Twankay, Imperial, and Gunpowder.

The chief ingredients of both black and green tea are a volatile oil, an alkaloid known by the name of theine or caffein, and tannin. The chief difference between black and green tea consists rather in the amount of volatile oil than of theine—the amount of theine being almost the same in both. Both of them readily yield their

active principles to boiling water, and both are chiefly used in the form of an infusion, the leaves being, as a rule, thrown away. There are one or two exceptions to this method of using tea. The Lipchus, on the Himalayas, prepare the infusion in the ordinary way; but after the tea has been drunk, the tea-leaves themselves are eaten. In Japan, also, there is a peculiar kind of fine tea, which is used only on most important occasions. It is of a pale green colour, and is ground into a fine powder. This powder is mixed with sufficient water to make it into a thin paste, and is then put into a small cup, which is handed round from one another, each person taking it with both hands, and drawing a little of the thin paste into his mouth by a quick inspiration. This tea, which by the kindness of Dr. Dresser I have had the opportunity of tasting, has a peculiar and strongly aromatic taste. Dr. Dresser, during his stay in Japan, was received by the Mikado, made a guest of the Empire, and had thus special opportunities of acquiring information. He informs me that this tea is very rare, and is used only on occasions of great solemnity; as, for example, in concluding the most important contracts. Amongst the Chinese, tea is infused only for a very short time. Boiling water is poured upon the leaves, and after standing for a few seconds only, is poured off and drunk. Long experience has probably taught them the advantage of this method, as by it they get most of the aromatic and stimulant effects of the tea without extracting the tannin, which tends to impair digestion. Taken in moderate quantity, the effect of tea is to cause a feeling of comfort with increased vigour of body, and still more of mind. It differs from alcohol and opium very markedly in this respect, that while the stimulant effects produced by these drugs are usually succeeded by depression, that of tea passes away without leaving any disagreeable after effects, though possibly this is partly due to the primary effects of the tea not being usually carried to such an extent as in the case of alcohol and opium. In large quantity, tea causes sleeplessness, and in larger still, produces excitement of the circulation, and such a disturbance of the nervous system that the patient suffers from hallucinations of vision and trembling of the muscles, somewhat resembling that in delirium tremens. These symptoms are produced much more readily by green than by black tea. In some exceptional cases, the susceptibility to the action of tea is so great that a few cups of green tea will bring on marked muscular tremors. Others, again, are so readily rendered wakeful by tea that they cannot sleep if they drink a cup after two o'clock in the day. Some-

times people suffer from sleeplessness without understanding the reason, when it is really due to their having drunk mixed tea, instead of black. They know the danger of green tea, and avoid it; but they sometimes drink the mixed tea without understanding that there is any green tea in it. Occasionally a cup of tea, instead of producing wakefulness, causes intense drowsiness. This is seen when a man has been engaged in hard work for many hours together, and feels very tired; but having still work to do, wishes to stimulate his brain by a cup of tea. He takes it, and to his disgust finds that he is at once seized with an overpowering desire to sleep. The reason of this, in all probability, is that the warm fluid dilates the vessels of his stomach, and by drawing blood from the already exhausted brain brings on the intense drowsiness. If the drowsiness can be resisted, it passes off after a little while; and when the tea begins to be absorbed, its stimulating effects upon the brain are felt. It has already been mentioned more than once that warmth is a most powerful stimulus to the heart, and the warmth of the tea has something to do with its stimulant action. Poor women, who are much underfed, and whose only comfort is a cup of tea, generally take it very hot, so as to add the stimulant effect of warmth on the circulation to the stimulant effect of the tea on the nervous system. The same class of people are accustomed to take their tea not only hot, but strong; and in order that no particle of its virtue may be lost, they infuse it for a very long time. In this way they extract a quantity of the tannin, and the combined effects of the tannin and the excessively hot tea upon the stomach, produce a condition of dyspepsia. It is not improbable that the other constituents of the tea may have something to do with this, as well as the tannin, for a single cup of tea taken in the afternoon will sometimes bring on great acidity and heartburn in a remarkably short time, even when the tea has not been taken hot. When long infused, its deleterious action is much greater, and the Chinese plan of infusing it for a few seconds is very much better than that usually employed in this country.

Tea is, however, sometimes blamed for causing dyspepsia, when it is not really the tea so much as the manner of using it. Before any other food is taken, one or two large draughts of tea are swallowed, and then, perhaps, the food is hastily bolted without complete mastication. We have seen that the stimulus of food tends to produce secretion of gastric juice, and that mastication also aids in this process; but when a quantity of fluid is swallowed first, it tends

to prevent the food which is taken afterwards from stimulating the walls of the stomach, and fluid drunk while food is still in the mouth washes it down, although it is so imperfectly masticated that otherwise it could hardly be swallowed. Mastication being consequently imperfect, the saliva is not secreted in any quantity, and thus two of the most important digestive juices being formed in insufficient quantity, digestion is imperfect, and dyspepsia is the result. Where the digestion is strong, it matters little what food the person takes, or when he takes it; but when the digestion is weak, attention must be paid to these minutiæ, and then it is advisable that when tea is taken with solid food, some of the solid food should be taken first, and well masticated before any of the tea is drunk. In such persons, also, it is better to avoid the use of tea together with butcher's meat, for in some way or other it seems to hinder the digestion of flesh more than that of farinaceous food. It has been said that this is due to the formation of tannate of gelatine, or leather, by the combination of the tannin in the tea with the gelatine in the meat. But whether this explanation be correct or not, the fact appears to be well established, that dyspeptics should avoid the use of tea along with, or shortly after, animal food.

As a beverage for quenching thirst during active exercise, few things are so good, and perhaps none is better than cold tea. In foreign travel, also, it is often advantageous to use weak tea instead of water. The water supply in many foreign towns is by no means good, and too often we hear of people who have gone abroad for health or pleasure, and have died while away, or shortly after their return, from typhoid fever. The germs of this disease are generally conveyed into the system by means of drinking water, and the danger from them is greatly diminished, and, perhaps, entirely removed by boiling the water before drinking it. But plain hot water, or water that has been boiled and allowed to cool, unless time has been allowed for its exposure to the air, is not a very agreeable beverage; whereas the addition of a little tea at once makes it pleasant. A most useful protection for travellers abroad, and especially for travellers in Italy, is to take with them a small etna and a little spirits of wine, so that they can boil a little water for themselves, and make weak tea whenever they wish. This can either be drunk hot at the time or cold afterwards, and by this simple precaution the danger from travelling is reduced to a minimum. In severe journeys such as the expedition to the North Pole under Sir George

Nares, tea is much to be preferred to alcohol. This was brought out very clearly in the report of the committee appointed by the Lords Commissioners of the Admiralty to inquire into the causes of the outbreak of scurvy in this expedition. In this report they state that the substitution of tea for alcohol in sledge travelling is attended with much benefit, and in the evidence which was given before them there was a general expression of approval of the tea carried by the sledge parties in the recent expedition, in the form of compressed tea. Tea is always preferable to alcohol for the mid-day meal; but, on account of its well-marked action in producing wakefulness, it is advisable not to use it shortly before the time of sleeping. Even at this time it is unnecessary to give alcohol, and all its advantages, without the risks inseparable from tea, may be obtained by the use of beef-tea at night.[1]

As a remedy tea is very efficient in many cases of headache, especially where this is of a neuralgic character. It should then be taken strong, and green tea is often more efficacious for this purpose than black tea. When tea is used in large quantity and infused long, so that it contains much tannin, it may give rise to constipation; but this is not usually the case when it is employed in moderate quantity and infused for a short time. In certain persons, indeed, it seems to have a laxative action.

The alkaloid caffein, or theine, which is found in tea, has been the subject of numerous investigations. When given pure to animals, or when taken by man, it seems to produce symptoms which remind us of the opium alkaloids, as it usually produces symptoms of excitement, but sometimes also of sleep. When given to frogs it produces tetanus, like thebaia; but it has also a very peculiar effect upon their muscles. In the ordinary frog of this country, the *Rana temporaria*, the muscles become stiff and rigid, as if dead, when a solution of caffein is applied to them, whereas this change is not produced in the muscles of the green frog, or *Rana viridis*, common in Germany. When very large doses are used, the tetanic convulsions are succeeded by paralysis and death. In warm-blooded animals the same condition of excitement is observed, and a slight touch causes them to shudder or fall into a tetanic convulsion. Moderate doses increase the strength and rapidity of the heart's beats and the pressure of blood within the vessels. The activity of the brain is usually increased, but some-

[1] "Report of the Committee appointed by the Lords Commissioners of the Admiralty to inquire into the Outbreak of Scurvy," p. 25.

times sleep is produced; the temperature is not much altered, but is rather increased. The tissue change in the body has been said to be diminished by tea and caffein, but this is not quite certain. It is a useful diuretic increasing the amount of solids excreted in the urine, and is therefore a remedy of considerable use in cases of dropsy. We have already mentioned, when speaking of alcohol, that the long-continued use of intoxicating liquors tends to cause disease of the kidneys, with insufficient elimination of waste products. In such cases caffein is frequently beneficial, either alone, or still better when combined with other diuretics. The physiological action of the volatile oil with which caffein is associated in tea-leaves has not been exactly ascertained, but probably a good deal of the effect of tea is due to this oil. The reason for supposing this is, that the amount of caffein in green and black tea is the same, and yet the effects of these two kinds of tea are very different. In China, also, tea is rarely used until it is a year old, as the new tea is said to have a peculiar intoxicating property. Persons engaged in packing and unpacking tea-chests are liable to paralysis after a few years' employment, and this has been attributed to the effect of the volatile oil upon them. It may, however, be simply due to poisoning by lead from the employment of lead foil in lining the chests.

Theine or caffein is contained, not only in the leaves of the tea plant, but in the leaves and berries of several other plants, which are also employed in the preparation of beverages. It occurs in the leaves and berries of the coffee plant, in the leaves of a species of holly which furnish the *maté* or Paraguay tea, and in the seeds of the *Cola* plant, used to prepare a beverage in Western and Central Africa. Besides these, a great number of other plants are used in various parts of the world as substitutes for tea. These are derived from many different orders of plants, but most of them belong to plants yielding tannin and a quantity of aromatic volatile oil, such as the *Myrtaceæ*, *Labiatæ*, and *Verbenaceæ*.

Coffee.

Leaves of the coffee plant contain nearly as much theine as those of the tea plant, and more than the coffee bean. They are prepared by roasting over a clear fire, until they become of a greenish-buff colour. They are then separated from the twigs,

which are again roasted, and the bark being rubbed off is mixed with the leaves. Their odour is very fragrant, and resembles a mixture of tea and coffee. With boiling water they give a clear brown infusion. When insufficiently roasted, the coffee leaves tend, like green tea, to cause sleeplessness, but when the roasting is complete their effect seems to be very much like that of tea or coffee. The coffee plant will bear leaves in some districts where it is not profitable to cultivate it for its fruit; and the natives in some places actually prefer the infusion of the leaves to the infusion of the bean, as being more powerful. The fruit of the coffee plant is a berry, containing two seeds, or beans, as they are popularly though incorrectly termed. These contain caffein or theine and a volatile oil having a powerful aromatic smell. This oil is developed during the process of roasting to which the beans are subjected before they are used. It is not produced in such large quantities from seeds which are perfectly fresh; and the best time between gathering and roasting differs with different coffees. Thus the small Mocha seeds will yield a full-flavoured coffee within a year of their being collected, whilst the larger American coffee, if roasted within a year, will develop but a poor aroma; and yet will become quite as aromatic as the Mocha if kept for seven or eight years. A mixture of two parts of Mocha and one of Java seems to yield a more aromatic beverage than either Mocha or Java coffee alone. The aromatic oil appears to be more volatile than in the case of tea, for coffee loses its aroma much sooner after roasting, and in order to be drunk in perfection, should be fresh roasted and fresh ground. Usually the coffee is made either by allowing boiling water to percolate through it, or else by simple infusion, and afterwards separating the grounds, either by allowing them to subside or by straining. In this country the grounds are usually thrown away as soon as the coffee is made.[1]

In Egypt the freshly-roasted bean, instead of being ground, is beaten in a mortar to an almost impalpable powder; it is then put with a small quantity of water and a lump of sugar into a little pan and gently raised to the boiling point, when it is drunk out

[1] I was told at Smyrna that the best way of making coffee was always to allow some of the old grounds to remain in the coffee-pot. This I have not tried, but I can speak from experience of the excellence of the result of mixing Mocha and Java coffee in the proportions given above, as well as of the product of the Egyptian plan of making coffee.

of tiny porcelain cups, the size and shape of an egg-shell, usually set in little filigree silver stands.

The difference between the action of coffee and tea upon the nervous system is perhaps not very easily distinguishable. It is stated, however, that coffee tends to give more sharpness to the critical faculties than tea; and it seems to have a greater power of antagonising the effects of alcohol than tea; it is, therefore, not unfrequently taken in order to counteract the effects of slight excess in alcoholic liquor. The difference between the actions of coffee and tea probably depends upon a difference in the quantity and quality of the volatile oils produced during roasting. It has been stated that the caffein from tea and from coffee is different in its action, and that that from coffee is the stronger. But this statement probably depends upon the fact that the experimentalist in one case used the pure alkaloid in his experiment, and in the other used it in the form of a salt, which, being more soluble, would have a more powerful effect. The activity of the volatile oil is shown by the fact that a certain quantity of coffee produces as great an effect upon a man as nearly four times the amount of caffein which it contains; and that coffee injected into the veins of an animal produces general convulsions, and also a tetanic contraction of the intestine; while caffein produces neither of these effects. The residue of coffee from which the caffein has been removed also causes convulsions and stoppage of the heart, but no tetanus.

Coffee is more apt than tea to disorder the digestion in many people, and in some is apt to cause a condition of biliousness. When taken in excess, it not only produces digestive disturbance, but nervous symptoms, palpitation, restlessness, irritability, sleeplessness, and general nervous depression. As a medicine, it is most useful in cases of poisoning by alcohol or opium: strong coffee being administered after the stomach has been evacuated by means of an emetic. It is sometimes used also to lessen nausea or vomiting depending upon the introduction of irritating substances into the stomach, and in cases of diarrhœa occurring after exposure to cold.

In most cases of dyspepsia coffee does not agree, and from its tendency to excite the nervous system it should also be avoided by those who are liable to suffer from various forms of nervous disturbance, such as functional palpitation of the heart and liability to attacks of neuralgia, hysteria, or epilepsy.

Coffee is not only often adulterated by admixture with other substances, but sometimes fraudulent imitations, which do not contain a particle of coffee, are sold under its name. The most common adulteration of coffee is chicory. This root is roasted before admixture, and it gives a slight bitterness to the coffee, which is to some so agreeable that they prefer the mixture of chicory and coffee to pure coffee. Beyond doing this and lessening the strength of the coffee (as the chicory contains no caffein), it has no injurious effect. Some coffees are made entirely of roasted figs. Other adulterations are roasted wheat and beans, flour, acorns, mangel-wurzel. To give it a colour burnt sugar is added. Some coffee is entirely made out of such substances. If no other adulterations are present, these substances are not actually injurious to health, only they have not the stimulating action of coffee. The infusion made with them is, in fact, a kind of toast and water, the burnt toast being replaced by burnt flour or burnt roots.

Chocolate and Cocoa.

Chocolate differs from coffee and tea both in its composition and in the method in which it is employed. Instead of being used as a simple infusion, it is made into a thin paste; and while tea and coffee are to be regarded as pure stimulants, chocolate is nutritive as well. The active principle of chocolate, also, instead of being caffein is theobromine. This is, however, very closely allied to caffein, the difference between them being that caffein contains in addition an atom of the organic radical [1] methyl, and is therefore methyl-theobromine. The cacao beans [2] contain about one and a half to two per cent. of theobromine, and six per cent. also in the husk of the bean.

Cocoa also contains an aromatic volatile oil which is probably similar in its action to that of tea or coffee, and like these oils is developed by the process of roasting. Cocoa differs from both tea and coffee in containing a very large proportion (almost half of its

[1] An organic radical is simply a group of atoms in such close chemical union that they behave, to a certain extent, like a single element; and methyl is a group of one atom of carbon with three of hydrogen.

[2] Cacao is the correct name of the tree and of the fruit and butter; cocoa, which is simply a corruption of it, is the name which is universally applied to the nibs and to the preparation made by grinding with starch and sugar.

whole weight) of a peculiar fat which from its appearance is generally known as cocoa butter.

The fruit of the cacao tree (*Theobroma cacao*) is oval in form, about six or seven inches long, and usually marked with ridges. It contains about fifty seeds, about the size of almonds, embedded in a soft pulp. When the fruit is ripe it is opened, and allowed slightly to ferment, so that the seeds can be removed very readily from the soft pulp. Before using it is roasted like coffee, and the aroma appears to be developed in this process. It is then manufactured in three ways. Firstly, it is simply deprived of its husk and broken to pieces, which form cocoa nibs ; secondly, it is ground, shell and all, between hot rollers, into a paste, and mixed with starch and sugar—it then forms cocoa; thirdly, the bean, after being shelled, is ground into a paste as for cocoa, and is then mixed with sugar and seasoned, usually with vanilla—this paste is chocolate. The purest form in which it exists is that of the cocoa nibs. When these are boiled in water they form a reddish-brown decoction, and the fat being insoluble in the water, comes to the top, and forms a scum; this is removed, and the decoction flavoured with sugar and milk. When cocoa is used in this way it acts more as a pure stimulant like coffee or tea, and less as a nutriment. Oils and fats being, as is well known, often difficult of digestion, cocoa may be taken in this way by dyspeptics, in whom chocolate, which contains the fat, would produce biliousness or sickness.

The shells, which are separated from the beans before these are broken up for nibs or ground into chocolate, also contain theobromine ; and when these are boiled in water they form a beverage which acts as a stimulant like coffee or tea, and may be used instead of them when they disagree, and when nibs are too expensive. These husks are usually sold at a cheap rate, and may be used with advantage by the poor.

In the preparation of cocoa, so as to form flake, granulated, rock, and soluble cocoa, the husks and the beans are ground together to form the best cocoa. An inferior sort is made from the smaller fragments of the nibs and a good deal of husk; and the lowest quality is made from the husk alone, with almost none of the bean it it. In some cases the cacao butter is removed from the cocoa during the process of its preparation, and this form is less likely to disagree with persons of weak digestion than ordinary kinds. The usual way of taking it is to put a large teaspoonful of the powder

into a cup, mix it well with a very small quantity of boiling water, then fill up the cup, adding sugar and milk to taste. Chocolate is prepared from the bean without the husks, and is made into a cake; this is scraped down, and then mixed, like cocoa, with boiling water or boiling milk. It is not infrequently eaten also in the form of bonbons or sticks, and when taken in this way it has a stimulant action on the brain reflexly through the nerves of the mouth, in the same way as smoking, besides having a stimulant action also after its absorption.

Minor Stimulants.

In Brazil a substitute for cocoa is used called *guarana.* The tree which yields this substance belongs to the same natural order as the horse-chestnut, and the seeds have just the appearance of small horse-chestnuts. They are prepared by pounding them in a mortar, and kneading them into dough with a little water. The paste is then made into round lumps or rolls like sausages, which are dried and hardened by the heat of the sun or a fire. These rolls are used in the same manner as chocolate, by mixing with hot water and sweetening the mixture. Unlike chocolate, guarana does not contain theobromine, but contains caffein, like tea or coffee. The quantity contained in it is very considerable, being twice as much as in good black tea, and five times as much as in coffee. It seems to have an action like that of tea or coffee; but, as it contains so much theine, and as a teaspoonful of guarana is used to a cupful of sweetened water, its effect is likely to be greater than that of either tea or coffee.

Like green tea, a cup of guarana is sometimes exceedingly useful in nervous headaches; sometimes it causes purgation, probably from containing an irritant substance called saponin. Saponin is the active principle in the Senega root, so much used in cases of chronic bronchitis, and we would expect that in this disease guarana might be usefully employed as a beverage in place of tea or coffee.

In Peru the natives are accustomed to use the leaves of the *coca* plant (*Erythroxylon coca*), which must not be confounded with cocoa. The leaves are dried and mixed with a little finely-powdered lime, and chewed in somewhat the same way as the betel-nut. In small quantities it is said to have the power of

enabling men to make long-continued exertions without any inconvenience. When used to excess it causes dyspepsia, and sometimes also nervous depression and hallucinations. It is to be noted that it not only contains an alkaloid cocaine, and another volatile one, hygrine, but also tannic acid; and it is probable that its local effect in the mouth, and also the movements of mastication which it induces, have much to do with its stimulant action, as trials made in this country with it have not shown it to be much more stimulant than tea or coffee.

The *cola-nut* is used along the tropical parts of the Western Coast of Africa as a stimulant. These nuts are about the size of a pigeon's egg, of brown colour; when sucked or chewed they have a bitter taste while in the mouth; but they give a pleasant after-taste to water or to food, and the natives of Guinea generally take a piece of the seeds before each meal. They are also nibbled throughout the day in somewhat the same way as the betel-nut, and apparently act as a stimulant and give pleasure in the same way as the betel-nut does. When used in this way, however, they are said to injure the appetite. It has been stated that when made into a paste and swallowed they remove the effects of alcohol very quickly, and will render a drunken man sober in the course of half-an-hour.

Kava is prepared in the Fiji Islands from the root of a kind of pepper. The natives chew it into a pulp, and then mix it with water and strain it; but Europeans simply grate or pound it. It has a stimulating effect like coffee, is most invigorating, and, by stimulating the secretion of saliva, speedily allays thirst. When taken in large quantities it destroys the power of walking, but leaves the head perfectly clear. The only injurious effect which it seems to produce is, possibly, impairment of vision.

Another substance, which is sometimes regarded more as a food than a stimulant, but which is nevertheless a stimulant in reality, is extract of meat, or beef-tea. In addition to the albuminous principles of which meat chiefly consists, it contains a certain quantity of crystalline organic substances, and of organic salts, especially potash salts. These are soluble in water, and are extracted by boiling in the process of making soup or beef-tea. When meat is thrown suddenly into boiling water, its exterior becomes at once coagulated by the heat, and forms a kind of case which prevents the water from reaching the inside, and retains the juices of the meat. Thus, if we wish to cook the meat by boiling,

we throw it at once into boiling water, so that it shall remain juicy; but if we wish to extract its juices, so as to make good soup, we must put it into cold water, and allow it to simmer for a long time, gradually raising it to the boiling-point. In making beef-tea we proceed in a similar manner; but in this case the meat is to be cut up into small pieces, so that the whole of the soluble materials may be extracted. Beef-tea, then, contains inorganic salts, especially potash salts, soluble, crystalline, and extractive organic substances, and also some soluble albuminous substances, and gelatine. When the beef-tea is boiled before serving, the greater part of the soluble albumens are coagulated, and fall to the bottom as a fine powder. When a small quantity of water is used to extract the meat, it dissolves so much gelatine that it forms a complete jelly when cold. Gelatine alone will not sustain life; but it is a useful nutriment when given along with other things. This gelatinous beef extract is, therefore, food as well as stimulant. It may be made by putting two pounds of lean beef with half a breakfast-cupful of water into a jar, and allowing it to simmer for four hours in a pan of water. In this preparation, also, the soluble albumens are contained, as well as the gelatine. A still larger quantity of albumen is obtained by the method originally employed by Liebig to prepare beef-tea for his sick servant. To one pound of fresh lean beef, finely chopped, are added eight ounces of soft water, with five or six drops of hydrochloric acid, and a small teaspoonful of common salt. This is stirred, and left for three hours. It is then strained through a hair sieve, the meat slightly pressed to remove all the fluid from it, and to ensure this more effectually about two ounces more water are gradually poured over it towards the end of the straining. This must not be boiled, as the albumens would thus be precipitated, and must be taken either cold, or gently warmed by placing it in a vessel of hot water. It is of a red colour, which is to some people disagreeable; but this may be avoided by adding a little burnt sugar. This form of beef-tea is also very nutritious. Another kind, equally good and convenient, inasmuch as it may be kept constantly at hand, is Valentine's meat juice. This is prepared by simply subjecting steak to enormous pressure in a hydraulic press, so that the whole of the juice is removed. This would be naturally apt to decompose; but it is evaporated *in vacuo* to a syrupy consistence. It then keeps perfectly well. One or two teaspoonfuls of this are added to a teacupful of cold or warm water, which

however, must not be boiling, or otherwise the albumen would be coagulated, but it may, however, be sufficiently warm to drink comfortably. Beef extract in the forms just mentioned is a very useful kind of food indeed for invalids who are able to take very little; but it is sometimes far too much relied upon, to the exclusion of other food, such as milk; and many people place reliance even upon ordinary beef-tea, or the ordinary Liebig's extract, for maintaining the strength of invalids, when these actually contain almost no nutriment at all.

In speaking of Liebig's extract we must distinguish carefully between the hydrochloric extract above described, which is nutritious, and the ordinary extract sold in pots, which is not a food but only a stimulant. This latter extract is prepared by the evaporation of beef-tea, and contains neither gelatine nor albumen. At first Liebig was inclined to ascribe to it great nutritive power, and to regard it as containing the same amount of nutriment as the meat from which it had been obtained. This view, however, was disproved by Voit, who showed that dogs fed upon meat extract quickly died. Liebig next supposed that although the meat extract was insufficient to maintain life, it would prove a useful addition along with other food. This view, however, was also disproved by Voit, whose experiments showed that not only did it fail to prolong life, but that in large quantities it acted as a poison. It is, therefore, of the very greatest importance that those attending upon invalids who are able to take very little food should not fall into the error of supposing that they can maintain the strength of the sufferer by the simple administration of beef-tea On beef-tea alone the invalid will starve.

Milk, on the other hand, contains all the elements essential to nutrition, and much more reliance is to be placed upon it as a food than on beef-tea.

Yet, at the same time, universal experience shows that beef-tea has a very beneficial action both in maintaining the strength in disease, and in removing fatigue and exhaustion occurring in healthy persons. Part of its stimulant action is no doubt due to its warmth; but this is not all, for cold beef-tea will also act as a stimulant. The exact mode of action has not been precisely made out, but it seems highly probable that it increases the activity of all the muscles, voluntary and involuntary, throughout the body. It has lately been shown by Professor Ringer that the heart of a frog when removed from the body will continue to beat for some time when a very

weak solution of common salt (chloride of sodium) in water, containing a mere trace of lime is allowed to flow through it. After a short time, however, the beats become altered in character, but when this alteration has taken place, if a small quantity of a potash salt is added to the solution, the natural form and rhythm of the beat is at once restored. The extract of meat will have an action similar to that of the potash. A similar effect of small quantities of lime, soda, and potash on the voluntary muscles has been recently observed by Cash and myself.[1]

The most important experiment, however, on the stimulant action of beef extract was made in the Ashanti campaign of 1874. This has already been alluded to when discussing the action of alcohol, but it may here again be mentioned, that while the stimulating effect of alcohol soon passed off and was succeeded by greater languor, each successive dose having less stimulating and greater depressing action, the extract of meat was quite a stimulating, left no after depression, and could be repeated without injury. It proved also more stimulating than coffee, and seemed to satisfy hunger and give strength, although it did not lessen thirst as the coffee did. The amount of meat extract necessary is about one ounce per diem. The coffee was better than the rum, but the quantity served out was probably insufficient, only one ounce being given, whereas probably no good effect would be obtained from less than two ounces.[2]

The advantages of beef-tea over alcohol under very different climatic conditions have also been pointed out by the committee appointed to inquire into the outbreak of scurvy in the Arctic expedition. In the report they say "that there can be no doubt that the dietetic use of alcohol is to be interdicted in men suffering from any symptoms of scurvy; and wherever its deprivation is not opposed to custom or acquired habit, it would be advisable to refrain from its use as a regular ration in the usual condition of Arctic sledge travelling." At night, when tea would be inadvisable from its property of interfering with sleep, beef-tea is recommended in place of alcohol.

[1] Brunton and Cash, Proc. of the Roy. Soc., No. 224, 1883.

[2] Parkes on the issue of a spirit ration during the Ashanti campaign of 1874.

ON THE RELATIVE DIGESTIBILITY OF WHITE AND BROWN BREAD.

IN CONJUNCTION WITH F. W. TUNNICLIFFE, M.D.

(Reprinted from *St. Bartholomew's Hospital Reports*, vol. xxxiii., 1897.)

MEDICAL men are often questioned by their patients, or their patients' friends, as regards the relative merits of white and brown bread. Accurate information upon this point is not so easy to get as would perhaps at first sight appear. Owing to the enterprise of bread companies of one kind or another, literature upon the subject is ample enough. Absolute value, however, seems to change sides, invariably ranging itself on the side of the particular bread company's bread from which the literature we happen to be reading at the time emanated. Under these circumstances we thought that a short discussion of the matter would not be either without interest or use.

First of all, it will be well to inquire what is the difference between white and brown bread? But before doing this, we might just notice very briefly what distinguishes leavened from aërated bread. This subject had better be considered first, because it is obvious that both white and brown bread can be leavened or aërated. The leavening of bread is performed by various methods, differing in details into which we need not enter, but consists essentially in mixing yeast with the dough. The yeast is, however, never pure, *i.e.* never contains only saccharomyses cerevisiæ, but mostly at the present time contains also organisms causing acetic acid and lactic acid fermentation. For this reason a watery infusion of leavened bread always presents a marked acid reaction. *Ex nihilo nihil fit;* in other words, yeast does not produce a fine spongy bread for nothing. The alcohol and carbonic acid gas formed by it is formed at the expense of the sugar in the dough.

Sugar is a very important nutrient constituent of bread, hence a loss of sugar diminishes the nutritive value of the bread in question. From one to two per cent. of the sugar contained in the dough is used up in bread averagely leavened in this manner. Most of the sugar thus converted is produced from starch; hence we can express this loss in terms of dough. One of the earliest scientists to appreciate this fact was the chemist Liebig, who calculated that by using yeast to raise bread, an amount of bread was wasted in Germany alone sufficient to supply 40,000 men. The result of this observation was the invention by Liebig of a baking-powder known as the Horsford-Liebig baking-powder. This consisted of acid phosphate of calcium and carbonate of soda. When this powder was mixed with the dough and the whole warmed, the acid phosphate decomposed the carbonate of soda, carbonic acid was evolved, and the bubbles of this gas escaping during the baking process rendered the bread spongy. Numerous other methods of aërating bread without yeast have been invented since the time of Liebig. The one perhaps best known in this country is the so-called Daughlish system, in which the flour is mixed under high pressure with water supersaturated with carbonic acid gas; the dough, upon being taken out of the vessels, rises, and is quickly baked.

The superiority, from a dietetic standpoint, of a well-raised bread as compared with a badly raised, is simply due to the fact that evolution of the carbonic acid gas takes place to a greater extent than we see. When one looks at a sample of bread, one is apt only to notice the big holes which are dotted over its cut surface, and to overlook the actual structure of the bread, which should be reticulate. In short, the carbonic acid gas makes, in its effort to reach the surface, a—so to speak—canalicular system throughout the loaf. When well-raised bread is taken into the mouth or stomach, this permeability which it possesses renders it much more easily accessible to the saliva or gastric juice, since the latter, by traversing the canaliculi formed during the process of rising, can get quickly to the remotest parts of any given lump of bread. In the case of a lump of solid dough, such as Yorkshire pudding, the digestive juices can only reach its remotest parts by osmosing through its substance, and this is a much slower business. As a rule, white bread is much better raised, *i.e.* has a much more reticular structure, than brown, and, as we shall see later on, the saliva acts much more quickly on the starch contained in white

bread than on that in brown. We can now return to the difference between white and brown bread.

There are breads of varying degrees of whiteness and varying degrees of brownness; for the purposes of our research we took the extremes of the two classes. For white bread, we bought the best white bread of a West-End baker; for brown bread, we employed whole-meal bread. White bread is made from flour which is derived from the central part of wheat granule; this yields both the whitest and the finest flour. Whole-meal bread is made from a flour which is not sorted, but derived from the whole of the wheat granule. The chemical composition of the wheat granule is not uniform from its centre to its husk. From this it follows that white flour, and hence white bread, does not contain those substances which are present in the peripheral layers and husk of the wheat granule. Chemically, the chief substances in which white bread is deficient as compared with brown are ash (consisting mostly of phosphates of potash, lime, and soda), nitrogenous matters, fatty matters, and cellulose. The composition of bread of course always differs quantitatively, according to the grain employed in making the flour, independently of, as well as according to the kind, coarse or fine, used; and hence the breads of northern countries differ somewhat from those of southern countries, in that, in the latter case, the excess of sun has an effect on the metabolic processes of the wheat or rye plant, as the case may be. Into this question it would be beside our purpose here to enter. To show the difference in chemical composition between white and brown breads, we cannot do better than give the following table :—

TABLE I.—*Percentage Composition of Various Breads.*[1]

Kind of Bread.	Water.	Nitrogenous Substances.	Fat.	Sugar.	Nitrogenous Free Extract.	Cellulose.	Ash.
Coarse white bread . .	39.95	7.58	0.10	4.47	50.47	0.33	1.20
Bosnian white bread .	53.72	6.59	0.33	2.00	34.97	0.78	1.59
Wheaten bread (small roll)	29.52	8.69	0.21	3.77	56.29	0.35	1.17
Vienna rye-bread . .	31.91	8.30	0.33	1.46	55.11	0.97	1.90
Pumpernickel	42.90	8.90	2.09	3.28	39.74	1.79	1.29

[1] These figures are derived from König's *Lehrbuch der Chemie der menschlichen Nahrungs- und Genussmittel.*

Of the breads given above, an extreme instance of brown bread is afforded by "pumpernickel," an almost black bread, which is eaten in Northern Germany, and which perhaps is only known to the tourist as being, in Berlin and the Rhenish provinces, invariably served with cheese in thinnish oblong pieces.

In the case of the two examples of bread which we used for our experiments, rather a more exhaustive analysis was necessary than that contained in Table I. For this analysis we are indebted to Drs. Schidrowitz and Rosenheim. To make the quantities of the different constituents more comparable, the results of the analysis are given in two forms—(1) as simple results, (2) calculated to water-free breads, *i. e.* allowance is made for the different amounts of water in the breads.

TABLE II.

	Percentage Composition of			
	Breads as Supplied.		Water-Free Breads.	
	White Bread.	Brown Bread.	White Bread.	Brown Bread.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Water	39.10	40.18	..	...
Dry substance	60.90	59.82	...	...
Total ash	0.59	1.88	0.97	3.14
Phosphoric acid	0.16	0.51	0.26	0.85
Soluble matter	4.73	7.54	7.77	12.60
Nitrogen	1.32	1.25	2.17	2.09
Albumen, calculated from nitrogen	8.25	7.87	13.54	13.16
Pure albumen	7.34	7.86	12.05	13.15
Soluble nitrogenous matter . .	0.61	0.73	1.00	1.22
Starch and saccharine matters, etc.	51.85	49.44	...	...
Starch	38.45	39.18	63.13	65.49
Sugar (maltose)	1.19	1.77	1.95	2.96
Dextrin	0.84	0.71	1.38	1.19
Cellulose	0.24	1.06	0.39	1.68
Fat	0.21	0.63	0.34	1.05
Acidity (lactic acid) . . .	0.19	0.29	...	...
Loss of water in fifteen days .	9.23	...	...	...

If we study the above tables, we shall see that brown bread differs from white in containing more fat, more salts, more water, and more cellulose. The amount of nitrogenous matter is, as a rule, more also in brown bread, but the difference is small.

Before leaving this, the chemical part of our subject, and entering upon the physiological one, we will briefly describe the microscopical differences between white and brown bread.

For this purpose the breads were made into a thin paste with water and dilute caustic potash, and a film of this was examined under a low power (one inch). In the white bread the outlines of the starch granules were found to be distinct, although the striation could not be seen. In the brown bread, on the other hand, the outlines were very much more blurred. This is very probably due to the fact that the crust of the brown bread is much less porous than the crust of the white. From this it follows that the steam generated in the loaf during baking, having less easy vent in the brown than in the white bread, is under greater pressure, and so becomes superheated. Hence the starch granules in the brown bread are much more disintegrated than in the white. This means that during baking the contents of a brown loaf are submitted to not only more steam, but steam at a higher pressure than the contents of a white loaf.

The mere chemical composition of any food-stuff is a very poor index of its nutritive value. A stick of charcoal, the atmospheric air, a little water, and some sea-salt contain all the elements of a typical diet, and in ample quantity; but the nutritive value of this composition is practically nil; hence it is not always a matter of what a food-stuff contains, but how it contains it. So long as a food remains in the alimentary canal it is outside the body, and if it cannot be acted upon by the digestive juices in such a way as to be rendered absorbable, it is as a food-stuff useless. The result of digestion is to convert insoluble substances into soluble ones. The chemical changes which concern us chiefly in the case of bread are the conversion of starch into sugar and albumen into albumoses or peptones. The conversion of starch into sugar takes place (*a*) in the mouth and partly in the stomach, and (*b*) under the influence of diastatic ferment of the pancreas in the small intestine. It is obvious that the digestibility of any bread, so far as concerns the conversion of starch into sugar, will be measured by the rapidity of this conversion. To measure this in the case of salivary digestion we proceeded in the following manner:—

Saliva was collected from three observers, after their mouths had been cleansed with water and the teeth brushed, to remove any particles of food that might be present. The saliva was next filtered, and then was diluted to twice its volume with distilled

water. Two grammes of each bread were then weighed out and placed in a small beaker; on to this 30 c.c. of distilled water was poured, and 30 c.c. of the diluted mixed saliva. The result was two digestive mixtures as follows:—

I.	White bread	2 grms.
	Distilled water	30 c.c.
	50 per cent. mixed saliva	30 c.c.
II.	Brown bread	2 grms.
	Distilled water	30 c.c.
	50 per cent. mixed saliva	30 c.c.

These mixtures were placed in an incubator and kept at from 35°–40° C. for half-an-hour; they were then taken out, and further digestion was stopped by bringing them briskly to a boil. The sugar in each mixture was then estimated.[1] The amount of sugar originally present in 2 grammes of each of the breads in question was then subtracted. The remainder gave for each bread the amount of sugar formed from 2 grammes of it in half-an-hour by the action of the saliva. These results, however, are not strictly comparable *inter se*, since the original amount of starch was not the same in each, the water-free brown bread containing 65.49 per cent. of starch, the water-free white bread 63.13 per cent. We can, however, calculate the total amount of sugar which could possibly be formed from these two amounts of starch, and then can express the amounts actually formed by the saliva in the case of each bread, as a percentage of the total amount which could be formed. The results will then be comparable *inter se*, and will be a measure of the relative digestibilities, in this respect, of the two breads under consideration. Before, however, referring to the table (Table III.) in which these results are shown, we will consider the action of the diastatic ferment of the pancreas.

The pancreatic diastatic digestions were made upon the same plan as the salivary ones. Benger's liquor pancreaticus was used. Each digestive mixture was made up as follows:—

I.	White bread	2 grms.
	Benger's liquor pancreaticus	15 c.c.
	Distilled water	45 c.c.
	A few drops of a saturated solution of sodium carbonate.	

II. The same as I., except that 2 grammes of brown bread were used instead of white.

These mixtures were left in the incubator at a temperature of 37° C. for seven hours. Further digestion was then stopped by

[1] The estimations were made by Alliher's gravimetric method.

bringing them briskly to a boil. While in the incubator the mixtures were from time to time stirred, and their reaction was seen to be alkaline. The sugar was then in each case estimated as before. The results of the diastatic digestions are shown in the following table :—

Table III.

	Fine Bread.	Whole-meal Bread.
Percentage of total possible sugar calculated to starch	70.14	72.76
Actual formed sugar :—		
(*a*) Saliva, half-hour . . .	21.64	9.99
(*b*) Pancreas, seven hours . .	36.07	19.75
Percentage of actual formed sugar to possible sugar :—		
(*a*) Saliva, half-hour . . .	30.85	13.73
(*b*) Pancreas, seven hours . .	51.42	27.14

From these tables it will be seen that in white bread the starch is much more rapidly converted into sugar than in whole-meal bread, both by the saliva and the pancreas.

Having completed the question of diastatic digestion, we next considered the digestion of the nitrogenous constituents. The nitrogenous constituents of bread consist chiefly of vegetable albumen or gluten ; this in the process of baking becomes associated very intimately with the carbohydrate constituents of the bread.

The method which we employed to ascertain the relative digestibilities of the nitrogenous constituents of the two breads consisted in submitting equal weights of them at the body temperature for equal times, to (*a*) gastric digestion followed by pancreatic digestion, (*b*) to pancreatic digestion alone.[1] It was not thought necessary to make experiments with gastric digestion alone, inasmuch as bread is never digested by gastric juice alone, either in health or disease. For, in cases where the stomach has undergone contraction of the pyloric orifice, such as to prevent the food from passing onward into the intestine, the condition of the patient is so grave that breads are not usually employed for his nutrition.

(*a*) *Gastro-Pancreatic Digestion.*—The digestive mixtures were composed as follows :—

[1] The method used really consisted in a modification of Stutzer's method. *Zeit. für Phys. Chemie*, ix. 211, xi. 207 and 536.

I. White bread	2 grms.
Benger's liquor pepticus	10 c.c.
Distilled water	50 c.c.

II. The same as I., except that 2 grammes of brown bread were taken.

These mixtures were placed in the incubator at 37° C., and allowed to remain there ten hours. They were from time to time stirred, and their reaction seen to be acid. At the expiration of this time they were brought briskly to the boil and filtered. As the filtering was somewhat special, it will be better briefly to describe it. The filtering medium consisted of purified asbestos and perforated platinum cones. The filtrate was thrown away; the residue together with the asbestos was carefully removed from the platinum cone and placed in a small beaker. The residue was then submitted to pancreatic digestion, as described above, for six hours, and again filtered in the same manner. The final manipulations consisted in estimating the nitrogen in the final residue, and multiplying it by 6.25 to convert it into albumen. This gave the amount of albumen which remained undissolved after gastric and pancreatic digestion, since the albumen which was rendered soluble by digestion passed through the filter and was thrown away. The nitrogen estimations were made by Gunning's modification of Kjeldahl's method.[1] Having thus obtained the amount of undigested albumen, this was subtracted from the total amount of albumen originally contained in the breads, and the remainder gave the amount of albumen dissolved, *i.e.* digested and thrown away in the filtrates. But since the breads originally contained some soluble albumen (see Table II.), in order to know accurately how much albumen had been digested, the quantity of albumen originally soluble in each bread must be subtracted from the total quantity of soluble albumen obtained after digestion. This was done, and the remainder gave the quantity of albumen actually digested. Before directing attention to the table in which these results are contained, we will briefly describe the experiments made upon the relative digestibility of the two breads in question by the pancreatic juice alone.

(*b*) *Pancreatic Digestion.*—Two digestive mixtures were made exactly similar to those used in the case of the pancreatic diastatic digestions. These were left in the incubator for eleven hours at a temperature of 37° C., and then were filtered exactly as in the case of the gastro-pancreatic digestions described above. The

[1] *Zeit. für Anal. Chemie*, 1889, p. 189.

nitrogen, however, in the residues was then estimated, and the numerical calculations were made as in the other nitrogen estimations.

As each bread contained originally a different quantity of nitrogenous matter (albumen), to make the results of the gastro-pancreatic and pancreatic digestions comparable *inter se*, we have expressed the amount of digestive albumen as a percentage of the total albumen originally contained in each bread.

TABLE IV.

	White.	Brown.
	Per Cent.	Per Cent.
Percentage of nitrogenous matter digested, calculated to total nitrogenous matter in water-free breads :—		
(*a*) Gastro-pancreatic digestion :—		
Ten hours gastric . . . / Six hours pancreatic . .	74.89	60.71
(*b*) Pancreatic alone, eleven hours .	79.38	69.61

From this table it will be seen that in the case of the gastro-pancreatic digestion of white bread, 14 per cent. more of the nitrogenous constituents were digested than in the case of brown. In pancreatic digestion the excess of nitrogenous matter digested in white bread amounts to nearly 10 per cent.

The next subject which we shall consider is the difference in the amounts of cellulose contained in white and brown bread. Upon reference to Table II. we shall find that the water-free white bread with which we worked contained 39 per cent. of cellulose, whereas the water-free brown bread contained 1.68 per cent. This differ-once is considerable. It does not, however, express the whole difference. Not only was the quantity different, but the quality. The cellulose in the breads was determined by the Wiender method, viz. by successive boiling with sulphuric acid, water, and caustic potash. After equal weights of bread had been treated in this manner in glass beakers, the residues were, even to the naked eye, very different both in quantity and quality. The cellulose in the beaker with brown bread was in thick, deeply pigmented flakes, and relatively large in amount, whereas the cellulose in the beaker with white bread was less in amount, and in very small, thin white flakes.

Cellulose is one of the most insoluble and indigestible substances known. Some cellulose appears to be absolutely indigestible; some, on the other hand, seems partially digestible. Some experiments were made upon this subject by H. Weiske.[1] This observer worked with the cellulose obtained from celery, carrot, and cabbage, and he found that from 62.7 to 47.3 per cent. of it was digested. The digestibility of cellulose contained in bread is probably very much less than this. In other words, in the human subject the nutritive value of cellulose can practically be neglected. Cellulose, however, has another property which we must consider. It exerts mechanically an irritant action upon the intestines. This action is in inverse proportion to the fineness of its division; in other words, the larger the flakes of cellulose, the greater the irritant action. The irritant action consists in stimulating intestinal peristalsis; as a result of this, sluggish intestines may be stimulated by brown bread up to the normal condition, whilst in irritable intestines it may not get exposed for a sufficiently long time to the action of the digestive juices; hence digestion may only partially take place, and both a loss of nutritive material and diarrhœa may ensue.

The last difference in these two kinds of bread of which we have to speak is the excess in the amount of fat and salts (phosphates) which is contained in brown bread. In this case chemical difference probably expresses pretty accurately nutritive difference. If we refer again to Table II., we shall find that while water-free white bread contains only 0.34 per cent. of fat and 0.26 of phosphoric acid, brown bread contains 1.05 per cent. of fat and 0.85 per cent of phosphoric acid. Probably, in fact almost certainly, all the salts and all the fat in bread are absorbed, and therefore, in this respect at any rate, if we neglect the fact that brown bread may remain for less time in the alimentary canal, brown bread is superior to white. A further difference between white and brown bread consists in the fact that minerals are present to a much larger amount in the latter. Practically, in many dietaries the chief source of calcium is the bread, and if this be deficient, not only may the bones be imperfectly nourished, but the muscles, heart, and other tissues also, and have their functional activity consequently impaired.

From the above experiments we are then justified in concluding that the higher nutritive value which we might, upon pure chemical grounds, ascribe to brown bread, cannot, with the single

[1] *Zeit. für Biologie*, 1870, p. 456.

exception of fats and mineral constituents, be maintained from the physiological side. On the other hand, distinctly less of the nutritive materials actually get into the blood in the case of brown than of white bread. The only other experiments upon the subject which we have been able to find, although obtained in an entirely different way, confirm our own results. Meyer[1] gave to dogs and men approximately the same quantities of different kinds of bread, with also the same quantities of beer and meat, over considerable lengths of time, estimating, meanwhile, the amount of fæces. In the case of both the fæces and bread, he made three sets of estimations, viz. total dry substance, nitrogenous constituents, and ash. The percentage of these constituents absorbed, in the cases of white bread and pumpernickel—the brown bread of which we spoke some time back—is as follows:—

Bread.	Total Dry Substance.	Nitrogenous Substance.	Ash.
	Per Cent.	Per Cent.	Per Cent.
White bread	94.4	80.1	69.8
	80.7	51.7	3.4

In experiments such as Meyer's, a large margin must be allowed for error. But the differences between the two rows of figures in the above table justify us in concluding that his experiments made on the living animal confirm ours, made with artificial digestive mixtures, and warrant us in regarding the results as accurate.

In our opinion, the above results allow us to formulate the following conclusions:—

I. White bread is, weight for weight, more nutritious than brown. Therefore it appears the preference given by operators in large towns for white bread has, to a certain extent, a sound physiological basis.

II. In the case of people with irritable intestines, white bread is to be preferred to brown.

III. In the case of people with sluggish intestines, brown bread is preferable to white, as it tends to maintain regular peristaltic action, and insure regular evacuation of the bowels, with all its attendant advantages.

IV. In cases where the proportion of mineral ingredients, and

[1] *Zeit. für Biologie*, 1871.

especially of lime salts, in other articles of food or drink is insufficient, brown bread is preferable to white. It is possible that in the case of operators living chiefly upon bread and tea, the preference for white bread which obtains in large towns may be responsible in part at least for the early decay of the teeth of those living on such a dietary.

V. An abundant supply of mineral constituents is especially required in pregnant and suckling women and in growing children, in order to supply material for the nutrition of the fœtus, the constituents of the milk, and for the growth of the tissues, especially of the bones. In such cases, if mineral salts, especially those of calcium, are supplied by other food-stuffs, drinks, or medicines brown bread is preferable to white.

VI. If the dietary is insufficient in fat, or if the patient is unable readily to digest fat in other forms, brown bread may possibly be preferable to white.

INDIGESTION.

A Clinical Lecture delivered at St. Bartholomew's Hospital, December 15, 1899.

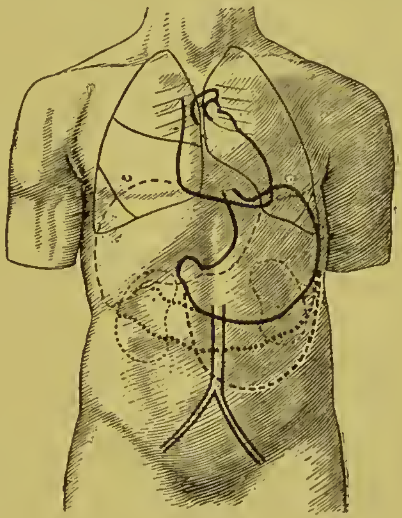
(From the *Clinical Journal*, April 25, 1900, vol. xvi. No. 1.)

GENTLEMEN,—As this is the last clinical lecture of this year, so it is the last, not of the nineteenth century, but of the last year in which we shall use "18" in the number of the year. I have therefore thought that instead of simply taking a case in the wards as the subject of my discourse to-day, I might take a subject of rather more general interest, one that will interest you very greatly between the time when we part to-day, and the time when you next come to hear a clinical lecture at St. Bartholomew's Hospital, for during that interval you will have been partaking of those festivities that have for many centuries occurred at this season of the year in this country. For how many centuries they have taken place we do not know, because it was long before the Christian era that feasts were held under the name of Yuletide feasts in honour of the year that was going out and of that which was coming in, when the shortening days of gloom and of darkness were just beginning to give place to the lengthening days of sunshine and warmth. When the Christian religion was introduced many of the old pagan feasts and ceremonies were adopted into it, and the festival that was at first intended to celebrate the coming of the new year was altered so as to represent the coming of the Child whose birth was to give to mankind a newer and better life. Both in Pagan and Christian ages these festivities have held an important place. They still do so, and they are to us a great landmark in the year, something which we look forward to with pleasure, and which we look back upon, in many cases at least, with satisfaction. But this satisfaction is occasionally tinged with a certain amount of,—shall I say, discomfort? for the very varied and tempting fare that we have at these Christmas festivities leads people occasionally to indulge rather too freely in the pleasures of the table. Now it is with the

object of telling you (1) why these discomforts come on, and (2) how you may best avoid or remove them, that I have taken the subject of Christmas festivities to-day.

Well, now, we have first to consider the amount of food that is taken at these feasts. There was once upon a time an American girl who was asked if she were hungry, and she replied, "No, I'm not hungry, but, thank goodness, I'm greedy;" and that is the feeling with which many people begin to partake of a Christmas dinner. The quantity that they get through is greatly increased by the variety of dishes, and mere quantity has a great deal to do with the discomfort that is felt afterwards. I have got here the *menu* of a dinner at St. Bartholomew's Hospital.

Menu.—Clear ox-tail soup, thick hare soup, stewed eels and



port wine sauce, boiled codfish and oyster sauce, fried smelts, ris de veau aux tomates, lark puddings à l'essence, braised turkeys, York ham and French salad, saddles of mutton, pheasants, sea-kale, gelées à la Brunswick, French pastry, compote of oranges, plum puddings, mince-pies, ice puddings, and bloater roes on toast.

In addition to all that there were the drinkables. There was sherry with the soup, hock with the fish, champagne with the roast, a liqueur with the ice, and after that came claret, sherry, port, and liqueur brandy. Now you can think of the condition of the unfortunate stomach after all these things are put in. Above is a diagram of the stomach where its outline, as it should normally be, is shown by a dark line. But after all these things have been put into it, it is probably very much bigger, as shown

by the dotted line. So that the mere fact that a considerably larger quantity of food is put into it than it was intended by nature to accommodate may have a good deal to do with possible indigestion afterwards. But it is not merely the quantity that is put in, it is also the variety of things which are put in. A number of those things whose names I read out to you, *e. g.* the salad, cannot be acted upon by the gastric juice at all. In all probability there was cheese, too, in that repast, which is very indigestible and breaks into lumps which are easily swallowed without thorough mastication. Mince-pies and plum puddings contain raisins, which are absolutely, or almost absolutely indigestible in the stomach and intestines. Supposing, then, that in the stomach there are lumps of various kinds, with a normal quantity of smaller particles of indigestible material, at the end of six or seven hours—the time during which an ordinary meal should have been passed from the stomach into the intestine—the overloaded stomach feels the need of emptying itself, and tries to do so. But the greater curvature of the stomach is much lower than usual, and the organ has an unusual burden to eject through the pylorus. The condition of the stomach is very like Mark Twain's celebrated jumping frog. This frog's name was Dan'l, and " he could get over more ground at one straddle than any animal of his breed." His owner, who kept him in a box, was very proud of the frog's jumping powers, and was always ready to bet on them. One day a stranger strolled in and inquired about the contents of the box. After a look at the frog he said, rather scornfully, " Well, I don't see any p'ints about that frog that's any better'n any other frog." This raised the indignation of the frog's owner, and he bet forty dollars that his frog would out-jump any other frog in Calaveras County. The visitor replied, " I'm only a stranger here, and I haven't got a frog, but if I had a frog I'd bet you." " All right," said the owner, " if you'll hold my box a minute I'll get a frog for you." And off he went. But when the visitor was left alone he opened Dan'l's mouth, and with a tea-spoon filled him full of shot nearly up to the chin, and set him on the floor. Then Dan'l's owner returned with another frog, and the two were put together with their forefeet even. One, two, three, and at a touch from behind, the new frog hopped off, but Dan'l simply gave a heave and hoisted up his shoulders, but he couldn't budge from the spot.

Now this is just what the over-filled stomach does. Instead of sending its digested contents into the duodenum, it simply gives a

heave and turns over. The lumps try to get through the pylorus, but they do not succeed; it will not let them through. In the meantime the alcohol in the stomach is undergoing fermentation, and so a quantity of vinegar is formed. By and by the stomach cannot stand it any longer; it is bound to get rid of its burden somehow, and the whole is accordingly ejected through the throat, after which the man is very much easier. But sometimes he does not get rid of the whole of it; much foul stuff is left behind, and he still has an uneasy sense of discomfort about his epigastrium. What is he to do? The best thing he can do is to drink a lot of water. It had best be lukewarm, because very hot or very cold water does not give rise to vomiting, while lukewarm water does, as you will find in the Revelation of St. John, where it says, "So then because thou art lukewarm, and neither cold nor hot, I will spue thee out of my mouth." Therefore you wash the stomach thoroughly out with lukewarm water. But even if you get the whole of it out, this stuff is so acid that it often sets the unfortunate person's teeth on edge—I can hardly call him a patient, perhaps I should call him the unfortunate sinner, as his sufferings are the result of his own fault. In order to neutralise this acid, which is smeared all over the mucous membrane, and which is still giving rise to irritation, you add bicarbonate of soda to the liquid. By that means you relieve the person very much. Sometimes vomiting does not take place spontaneously, and the old Romans, who were still greater gourmands than we are, found that their stomachs would not hold all that they wanted to put into them. So if you go to-day to the Palace of the Cæsars of Rome, you will find a little place adjoining the banqueting hall where the Romans used to make themselves sick and empty their stomachs, so that they could go back to the hall and have some more. In this country, as a rule, when people have filled their stomachs too full they do not follow the Roman example, and go back to the dining-room after emptying them, but, like the Romans, they sometimes seek relief by getting them emptied. And they probably attain their object in the same way as the Romans, either by putting the finger down the throat, or by tickling the fauces with a feather. There is one point to be observed about the finger, and it is that, unless the nail is cut very short, it may scrape the throat so as to leave it very uncomfortable for a day or two afterwards. Therefore the nail should either be short, or the fauces should be tickled with something softer than the finger, such as a feather. A friend of

mine told me that he was very liable to indigestion, and that it was his practice, immediately on returning from a dinner, to use the stomach-pump and wash that organ thoroughly out. In this way he said he saved himself from a great deal of trouble and discomfort. But surely a much better plan than his is to prevent indigestion rather than cure it, and be content with a smaller quantity, and with less variety of food.

But supposing that indigestion has occurred, and that the gourmand has got rid of the excess of food, what is to be done with the mucous membrane of his stomach, which still remains irritated by the very acid substances formed by the decomposition of food and drink? Very often it happens that if you simply allow such patients to abstain from food altogether for a while, and thus give the stomach a rest, it recovers quickly without any other help. And fortunately the irritation of the gastric mucous membrane which succeeds to the ingestion of too much food and drink, leads to a condition of lack of appetite or even nausea, which prevents the patient from taking more. But if the patient should not feel this, it is wise for you to insist upon giving the stomach a little rest after the over-exertion to which it has been subjected. Let the patient take very little food for the next day, and that only of a very plain sort, such as a little tea and toast, and some boiled rice or Indian corn-flour, or something of that sort—a plain, light diet. If this is not sufficient to remove nausea, you may give the patient some bismuth, bicarbonate of soda, spirit of chloroform, and cinnamon or peppermint water. By such means you will probably find that the stomach soon gets all right again. But sometimes, instead of the stomach retaining all the food, it allows some of it to pass into the intestine, and there the food, partially decomposed, and to a great extent unmasticated, acts as an irritant also, and fortunately produces diarrhœa, very frequently accompanied by griping. The gripes of course are unpleasant, but the diarrhœa is beneficial. One of the best ways of treating such diarrhœa is not to give opium, but to give a dose of castor oil with a little opium in it, say one-half to one ounce of castor oil, with five or ten minims of laudanum in it. The castor oil clears out all the particles of undigested and fermented food, and the small dose of opium in it tends to lessen the irritability of the intestine afterwards, to prevent the griping, and to prevent the diarrhœa from going on too long. Castor oil is an exceedingly good thing in more ways than one. An old fellow-student of mine told me that at

Christmas-time his father, who was also a doctor, used to say to his children, "Now, boys, just look here; here are all these things upon the table; you can eat any one of them and all of them, and as much of them as you like, but if you are ill,"—and here he pointed to a bottle of castor oil on the shelf. The idea of getting it acted as a deterrent from their eating too much, and saved them from the necessity of taking castor oil afterwards as a curative remedy. In the ways I have mentioned you will generally be able to remove the consequences of the first attack due to indiscretion in diet.

But it is just possible that something much more acute might come on which will not be arrested by the means I have mentioned. I have been supposing hitherto that all the articles of food eaten were perfectly healthy and sound. But occasionally you may get articles of food which are not sound, and sometimes it is exceedingly difficult to find out which are and which are not sound. Some time ago I was at dinner at a patient's house; the dinner was an exceedingly good one, and after it I remained perfectly well, and so did all the members of the patient's family. But the doctor who was in attendance on the patient, immediately after dinner said that he felt squeamish, and when I went to his room I found him violently sick, his face very pale, his cheeks shrunken, and he was covered with a cold clammy perspiration. He remained in a state almost of collapse for about a couple of hours, with violent vomiting and some purging. He and I had apparently eaten exactly the same things with one exception; I had not taken any grouse, and he had. But some of the other people who were at the dinner had also eaten grouse,—and the only explanation I could give of his attack was that he had got a bit of grouse which had been rendered bitter by the gall of the grouse,—that, in fact, my friend had eaten some poison, which had produced this effect upon him.

Now in cases where you have to deal with vomiting and purging due to some poisoning by food, the first thing is to have the stomach thoroughly emptied by hot water, and then the best remedies are opium, alcohol, and belladonna. Sometimes hot brandy-and-water given internally will relieve very considerably, and it is well to give the brandy-and-water rather strong, putting as much boiling water with the brandy as will make it fairly hot, but taking care not to dilute it too much. The only thing which eased my friend was the subcutaneous injection of morphine. Under the

influence of this his pain and vomiting ceased, and he fell asleep. Belladonna, however, is sometimes even better than morphine, and it may be given, if necessary, subcutaneously in a dose of $\frac{1}{100}$th grain of atropine, or it may be given internally in the form of tincture of belladonna or the Liquor Atropinæ Sulphatis.

Now there are many people who do not overload their stomachs to quite the same extent as the persons I have been describing, but they take too many meals, and too large meals, and too rich meals day after day. Perhaps they have got the whole Christmas week to do it in, and though they are well for the first two or three days, they do not feel very well at the end of the week. There is a point which I think is too little considered, which is that all the blood from the stomach has to go through the liver before it can get into the general circulation, and that any condition of the liver that prevents the free circulation of blood through it will tend to congest the stomach. Now the cells of the liver during fasting are smaller than they are after a meal, and as the cells are larger after a meal, they will tend to lessen the room available for the passage of blood through the liver, and consequently when the liver becomes congested the circulation of blood through the stomach becomes less. Our ideas concerning the condition of the mucous membrane of the stomach under various influences are derived chiefly from the observations of Dr. Beaumont on the stomach of Alexis St. Martin. Through a hole which had been accidentally made in St. Martin's abdominal wall and stomach by a charge of buckshot, Dr. Beaumont was able to see the condition of the mucous membrane after any excess. He found that after St. Martin had taken more alcohol than was good for him, the inside of the mucous membrane of the stomach was studded with little pustules, almost like acne, and that this condition disappeared after St. Martin had taken some calomel. The good effect of the calomel upon the stomach was most marked, but I think its action was not so much direct as indirect through the liver. I am inclined to suppose that it acted on this organ in such a way as to assist the circulation through it, and so to restore the circulation in the stomach to its normal condition. You will often find persons who habitually eat and drink too much get the greatest possible relief from a dose of calomel followed up by some saline next morning; calomel has not the deterrent power of castor oil; it has no disagreeable taste, and so patients will go on taking it twice a week for years and years, whereas most patients

object very much to taking castor oil more than once if they can avoid it. So calomel has one advantage and one disadvantage. Its advantage is that it is a very good curative agent; its disadvantage is that it has not the same power of protecting the individual from committing subsequent indiscretion as castor oil. There is another drug which has a somewhat similar action, namely, Gregory's powder—rhubarb, magnesia, and ginger—it is a good remedy, acting on the stomach, intestines, and liver, and its disagreeable taste tends to prevent people from indulging too much in the pleasures of the table, and thus requiring to take it often.

We have now to consider another class of case which you may have to deal with during the Christmas holidays, namely that of people who cannot enjoy Christmas fare at all. We have been talking hitherto of healthy people who are likely to eat too much, but there are some people who are likely not to be able to eat enough because they suffer from chronic indigestion, due either to some previous excess on Christmas or some other occasion, or possibly to the conditions of life between Christmas holidays. They may have been closely confined, overworked, overworried in one way or another, and their digestion has broken down. You must try your best to get their stomachs into such a condition as to allow them to enjoy their Christmas fare. In talking of the treatment of indigestion I shall be obliged to tell you a great many things you know already; so many, in fact, that probably you will be inclined to say, "I knew all that before; what is the use of telling me?" I want you to bear in mind the story of the wren. The wren is almost the only bird that builds a nest with a top to it. The story goes that years and years ago the birds held a meeting, and they wanted the wren to teach them how to build a nest. The wren said, "You take a piece of stick and lay it so, cross-wise on the branches of the tree." "I always did that," said the owl. "You then take another stick and put it so." "Oh," said the crow, "I have always been accustomed to do that." The wren then took another stick and showed how that was placed; but the other birds said they had already done that themselves. After this had gone on for about half-a-dozen times, the wren said, "Evidently you all know how to build a nest, so go your own ways, for I won't teach you any more." The consequence is that all the other birds only build half nests to this day.

I am going to tell you several things which you know already,

but perhaps I may put them together in a slightly different way. I may tell you that few and simple as the rules are which I am going to give you, it has taken me long years of work to enable me to formulate them.

First of all, in cases of indigestion you must bear in mind that the first part of digestion is mastication and insalivation; that if the food is not perfectly comminuted by the teeth and perfectly insalivated by the saliva, it throws too great a strain upon the stomach. The stomach is a long-suffering organ, but when the stomach does go on strike it is a bad thing for the individual. The teeth are sometimes deficient, and in these cases they must be supplied. But in many more cases the teeth are fairly good, but the patients will not give them time to act; they bolt their food. I dare say you may have heard what is said to happen somewhere in America.

There was a place, I was told, far out west—I did not get so far myself when I was in America—where, when you arrive at the railway station you simply go to an office, like an ordinary ticket office, and plank down your dollar. Instead of giving you a ticket they tell you to put your open mouth to a sort of tube like the end of a sausage-making machine; round goes a wheel, and down goes the whole breakfast into your stomach before you can say Jack Robinson. You then move on and the next man takes your place. Now it isn't necessary to go to America to see this sort of thing, for the same process may be observed in many a city restaurant; not quite so quickly, but very nearly so. The people there have not yet reached the pace that they are said to have done out west, but they are doing their best to rival them by taking their meals as fast as they can.

The first rule to be given to your patient who suffers from indigestion is—Eat slowly, masticate thoroughly, insalivate completely. You may think these things are all the same, but they are not. Many patients will tell you that they eat slowly, yet they do not masticate thoroughly. Perhaps they have not grinders wherewith to grind, and they do not insalivate completely because they do not move the food about sufficiently in the mouth. Without mastication the food goes down into the stomach in lumps, and without insalivation the farinaceous parts of the food go down without coming into contact with the saliva which is to convert it into sugar and thus digest it. I have seen a man stick his fork into a whole new potato, and with a gulp and a

gobble, but without any pretence of mastication, he, as the Americans say, "got outside it." Then he complained that new potatoes were indigestible. If the patient will not of his own accord follow the rule you have given, he must, if necessary, follow Sir Andrew Clarke's rule, count the bites. For every mouthful of meat he must allow thirty-two bites, or one bite to every tooth. If the meat is tough he must allow sixty-four bites, and if very tough it may require ninety-six bites. You would hardly believe that meat would take so many bites to comminute it till you try, but it is a fact nevertheless.

The next rule is, let the patient take his solids and liquids separately. The reason for this is, that if a patient with a weak digestion swallows much liquid—whether it be soup, plain water, mineral water, whisky-and-water, or beer does not matter—he dilutes his gastric juice, and thus lessens its digestive power. So it is better for a patient who has weak digestion to take his food without liquid. There is, however, one exception to this, and that is breakfast, because at breakfast the food is generally of a softer character and chiefly farinaceous, and therefore you may allow a little more latitude in this respect. But there is another reason for making the patient take food and liquid separately, and that is that you cannot get down unmasticated food without liquid. If you drink during a meal you may chew very imperfectly, and wash lumps of unmasticated food down with the liquid. So that even at breakfast you tell the patient that he can, if he likes, take a breakfast cupful of tea, not strong, *but towards the end of the meal.* Of course the gastric juice is diluted by the tea, but it does not matter so much in the case of farinaceous food as it does in the case of luncheon and dinner, at which proteid materials enter largely into the composition of the food.

In many cases those rules are sufficient to remove dyspepsia. But in cases where they are insufficient the third one comes into play.

Let the patient take his farinaceous and proteid foods at different meals. That is to say, he may take bread and butter for breakfast, but he must take neither fish, eggs, nor meat. In the middle of the day he must take fish, eggs, or meat, but no farinaceous food whatever. At about five o'clock he should again have a farinaceous meal, as at breakfast, and again at eight he should have a proteid meal, such as he had at luncheon. You see that only food of the same kind is put into the stomach at each

meal, and so there is no delay from the different digestibility of the different kinds of food, the whole contents of the stomach become comminuted and digested and passed on into the intestine about the same time.

With those three rules you will find you will be able to cure a great number of your dyspeptic patients.

But it is absolutely necessary that your patients should have some fluid, and I have just said it is advisable not to give them any fluid at meals. When, then, are they to have it, and what are they to have? The best liquid they can drink is hot water, and the best times to drink it are on rising in the morning, again between eleven and twelve in the forenoon, again about four or five o'clock in the afternoon, and, lastly, at night before going to bed. By this means you give the patient all the fluid he requires, yet you do not give it so that it will dilute the gastric juice when it is needed for digestion, but rather when it will assist in washing out of the stomach the remnants of the previous meal. By giving it at twelve o'clock you tend to wash the breakfast out of the stomach; at four o'clock it washes out the remains of the luncheon; and so on. In this way you tend to keep the stomach clean for the succeeding meal.

In cases, however, where the stomach is weak we may find it an advantage to supplement the normal gastric juice by giving some acid and pepsin; and apparently there is an advantage sometimes in giving mixed enzymes; not pepsin alone, but pepsin containing rennin. I remember being a good deal astonished a number of years ago on making some experiments to ascertain the digestive power of some of the essences of pepsin that are in the market—to find that one, which I knew from clinical experience was a useful remedy, had almost no pepsin in it at all; and I wondered how it could be so until I found by a further experiment that, although there was very little pepsin in it, it contained a lot of rennin. So you may find sometimes that in one patient one preparation of pepsin will do good, and in another patient another kind will be beneficial.

Then just before meals it is often advisable to give a little alkali, which tends to stimulate the secretion of gastric juice. The common way of giving this stimulant is with some bitter, such as calumba, containing no tannin; and this seems useful when the stomach is not irritable and where there does not seem to be much catarrh. But if there is much catarrh in the stomach, we often

get better results from substances containing tannin, such as the infusion of gentian; and in a number of those cases with flabby tongue the addition of perchloride of iron often answers very well. Tannin and perchloride of iron do not go well together—they make an inky mixture;—so when we give the perchloride of iron we give it with quassia. Where the tongue is large, pale, flabby, and marked by the teeth at the edges, we sometimes get better results from quassia and iron than we do from pepsin and other things which you might at first think were very much better for the patient.

In some cases where the habit of taking large meals or drinking large quantities of water has led to dilatation of the stomach, not merely for a single time, but more or less permanently, the plan I have mentioned of taking fluids and solids at separate times very often aids greatly in restoring the stomach to its normal condition. But where it does not, then the use of a soft rubber tube to wash out the stomach either every morning just on rising, or every night before going to bed, will often help very greatly. In cases where you have to deal with permanent dilatation of the stomach due to pyloric contraction, the only remedy is gastro-enterostomy, and on the whole this is a very satisfactory operation; but I hope it may not be necessary in the case of yourselves or your friends.

And now, gentlemen, I think I have said enough to qualify you, first of all, to prevent the occurrence of indigestion in yourselves, and, secondly, to cure it in any of your friends.

ON ABSORPTION OF GAS BY THE INTESTINES AND THE ACTION OF CARMINATIVES UPON IT.

IN CONJUNCTION WITH J. THEODORE CASH, M.D.

(From *St. Bartholomew's Hospital Reports*, vol. xxii., 1886.)

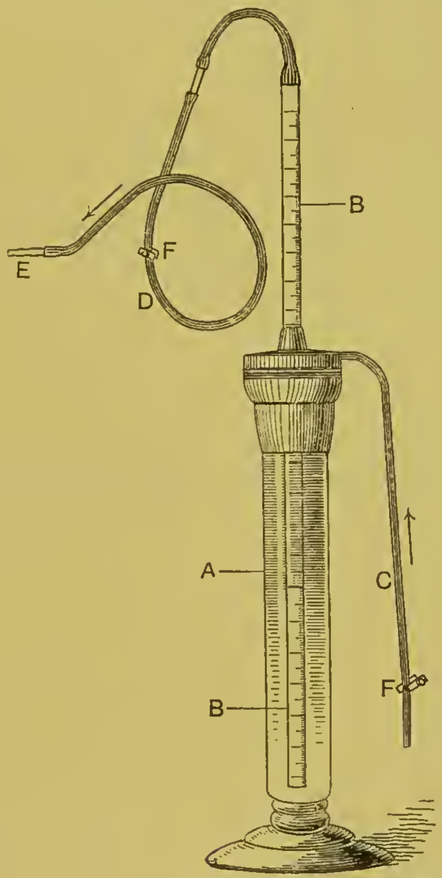
THE experiments upon which this paper is based were performed six years ago. It was at that time our purpose to extend the investigation further, but another line of research having claimed our attention, we have been obliged to postpone the further study of gas absorption. It seemed advisable, therefore, to publish without further delay the results, incomplete though they be, at which we arrived, as they tend to throw some light upon an obscure subject.

The effect of carminatives in relieving flatulence is a well-known fact, but the *modus operandi* of these remedies has not yet been determined. It seemed probable that their action might depend to a great extent on increased peristaltic movements of the stomach and intestines, leading to the expulsion of gas; but the possibility of their causing increased absorption of gases from the intestines was a factor the value of which it seemed to us advisable to determine. For although the gaseous interchange which takes place between the blood and the gas or air, which is only separated from it by a thin layer of tissue, is no doubt much less in the intestine than in the lungs, yet it is probable that such an interchange does take place. In certain cases of heart-disease, and in the early stages of cirrhosis before ascites appears, the tendency to flatulence is greatly increased, a fact which leads one to think that the distension occurring in these cases may be due to the diminished absorption of gas from the intestines consequent upon the obstruction of the flow of venous blood through the vessels. In order, then, to make out how far the absorption of gas from the intestines might be influenced by the action of carminatives, the experiments detailed in this paper were undertaken.

The essential parts of the apparatus employed were—

1. A *gasometer* connected with generating and purifying bottles for the production of different gases. This gasometer had a cubic capacity of three hundred centimetres.

2. A *discharge gasometer*, consisting of a finely graduated burette, partially immersed in a second glass chamber containing



DISCHARGE GASOMETER.

A. Outer cylinder containing water.
B. Burette of gas.
C. Pressure tube.
D. Exit tube for gas, with
E. Cannula.
F. Clamp.

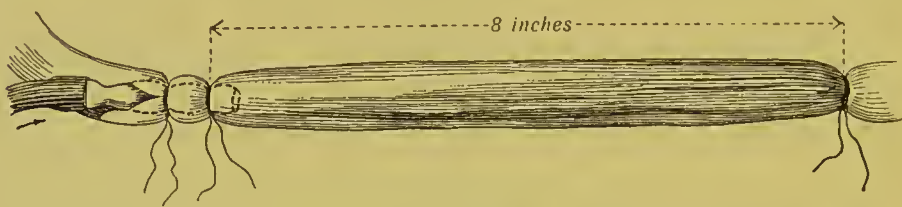
water, and closed at the top by a sheet of india-rubber, through which the burette passed, the opening being rendered air-tight by a ligature. By this means powerful positive or negative pressure could be produced at will in the inner chamber.

3. A system of *closed tubes* connecting the burette with the cannula, containing a glass stop-cock (air-tight).

4. Wide-mouthed double-necked cannula, having a double

constriction round the neck, in order that two ligatures might be applied to insure the connection of the tubes with the interior of the viscera being air-tight.

The principle of operation was thoroughly to anæsthetise the animal, at first with chloroform and then with æther; to perform tracheotomy and connect the tracheal cannula with an æther bottle provided with the regulating stop-cock recommended by Dr. Brunton; to expose the intestine by a mesial abdominal incision, and, after measuring out its length, to ligature, doubly below and triply above, two of the three upper ligatures embracing the cannula, the third obviating hæmorrhage from the division which had been entailed by the introduction of the cannula; to keep the exposed viscera in a warm steam-chamber connected with a glass flask containing warmed water; to maintain the general heat of the animal by keeping it carefully covered by



Glass cannula *in situ* (diagrammatic).

cloths and cotton wadding. By observing these precautions the circulation was maintained in the mesentery exposed for an indefinite period. Before the introduction of the cannula all the intestinal contents were, by gentle pressure, removed from the part of the intestine experimented on.

Estimations were made half-an-hour after the injection of gas by returning the gaseous contents of the intestine into the burette *under suction*. By taking care that the part of the gut under examination distal from the cannula was first emptied, the exit of all contained gas was insured, and the cannula being then closed, the gut remained empty until another injection was made a few minutes afterwards. The first three experiments are merely given in abstract in the schedules, as the method employed in them was less reliable than that which was afterwards adopted, and we are not inclined to attach much importance to the results. We had not at the time they were performed begun to employ the

finely graduated apparatus we have just described in place of the less accurate instruments which we had recourse to at first. Another point of importance is, that in the first three experiments gas was removed by pressure, whilst in those following, suction only was used.

The amount of absorption which occurred in the first three experiments was enormously greater than in the later; and although we are not inclined altogether to accept their results on account of the imperfection of our apparatus, we think they are nevertheless deserving of some attention, and, had time and opportunity permitted, we should have repeated them with the more exact apparatus. The chief difference in the effect of pressure and of suction upon the intestine itself is that the latter simply removes the gas from the interior of the intestine without acting on the intestinal walls. Pressure, on the other hand, both removes the intestinal contents and acts as a powerful stimulus to the intestine, affecting its muscular coats, the nervous plexuses contained in them, and the circulation in their blood-vessels. The stimulus of pressure causes increased peristalsis of the intestine, mechanically removes the blood from the venous radicals, and tends to cause dilatation of the arterioles. The circulation is thus accelerated in the intestine, and greater facility is thereby afforded for the absorption of any gas which it may contain.

The gases which we employed in these experiments were—

1. Atmospheric air.
2. Carbonic acid gas.[1]
3. Hydrogen.
4. Marsh gas (from sodium acetate and soda lime).
5. Coal gas (impure).
6. Sulphuretted hydrogen.

The carminatives used were oil of cloves (ol. caryophyll. B.P.) and asafœtida. The experiments in which more than one gas was tested were commenced by the employment of either air, CO_2 or H, and were terminated by gases apt to prove injurious and disadvantageous to subsequent absorption by reason of their action upon the circulatory and respiratory systems, as marsh gas, coal gas, or sulphuretted hydrogen.

In each series of experiments the gases were tested in the first

[1] In the tables showing the estimation of CO_2, allowance has been made for the absorption of the gas by water during the process.

instance alone, and then again after the administration of the carminative.

We shall proceed to quote a few experiments in detail, but must refer for the others to the synopsis at the end of this paper.

Results in Detail of Subsequent Experiments.

EXPERIMENT IV.—Female Cat (middle-sized and healthy).

Gas.	Time.	Injected.	Time after.	Estimated.
Air .	11.5 11.7	Large int. 11 c.c. Small int. 8.8.	Half-an-hour later	Large int. 10.5 c.c. Small int. 8.6 ,,
Air .	11.45 11.47	L.I. 8.3 c.c. S.I. 9 ,,	,, ,,	L.I. 8.3 c.c. S.I. 8.8 ,,
H .	12.25 12.27	L.I. 10 ,, S.I. 10 ,,	,, ,,	L.I. 11.5 ,,[1] S.I. 10 ,,
CO_2 .	1.15 1.17	L.I. 10.2 ,, S.I. 10 ,,	,, ,,	L.I. 9.9 ,, S.I. 9.4 ,,
Air + oil 2 gtt.	2.0 2.2	L.I. 10.2 ,, S.I. 10.2 ,,	,, ,,	L.I. 9.8 ,, S.I. 9.8 ,,
H + oil	2.45 2.47	L.I. 9.9 ,, S.I. 10.2 ,,	,, ,,	L.I. 9.7 ,, S I. 10.2 ,,
H + oil	3.30 3.32	L.I. 10 ,, S.I. 10 ,,	,, ,,	L.I. 9.9 ,, S.I. 9.7 ,,
CO_2 + oil	4.0 4.2	L.I. 10.3 ,, S.I. 9.8 ,,	,, ,,	L.I. 9.8 ,, S.I. 8.8 ,,

[1] This result is exceptional, but we could not perceive any cause of error in the experiment, and it would point to the possibility of secretion of gas by the intestinal mucous membrane. The gas removed was not analysed, so we are unable to state its composition.

EXPERIMENT V.

Cat (Healthy Female).

Operative proceeding as usual. Large intestine 6½ inches, from cæcum to descending colon. Small intestine 9 inches, at junction of jejunum and ileum.

Gas.	Time.	Injected.	Time after.	Estimated.
Atm. air .	11.13 ...	L.I. 10.4 c.c. S.I. 11.1 ,,	Half-an-hour later	10.3 c.c. 11.0 ,,
H . . .	12.0 ...	L.I. 10.7 ,, S.I. 10.2 ,,	,, ,,	10.7 ,, 10.2 ,,
CO_2 . .	12.50 ...	L.I. 12.0 ,, S.I. 11.2 ,,	,, ,,	11.6,, 10.6 ,,
CO_2 + ol. car. 2 gtt. + olive oil . .	1.45 ...	L.I. 11.3 ,, S.I. 12.6 ,,	,, ,,	6.0 ,,[1] 6.0 ,,
CO_2 + oil of last experiment still in intestine .	2.23 ...	L.I. 10.2 ,, S.I. 10.2 ,,	,, ,,	5.8 ,,[2] 5.7 ,,
H. Oil not again injected . .	3.10 ...	L.I. 10.7 ,, S.I. 9.7 ,,	,, ,,	10.4 ,,[3] 9.2 ,,
Atm. air. Oil not again injected. .	3.55 ...	L.I. 11.2 ,, S.I. 7.4 ,,	,, ,,	11.4 ,, 8.4 ,,

At end of experiment animal normal. Circulation in mesenteric vessels good. Peristalsis in ligatured intestine active.

[1] Experiment having very marked result, repeated with every precaution against possibility of error.

[2] Much secretion had occurred.

[3] Great amount of secretion.

Experiment XVII.

Cat (Healthy Female).

Operation as usual, but three intestinal regions taken, viz. large intestine (cæcum), 6.5 inches; two portions of the small intestine were isolated, viz. (1) ileum, 9 inches, and (2) duodenum and jejunum, 13 inches.

Gas.	Time.	Injected.	Time after.	Estimated.
Air	12.15	L. I. 8.4 c.c.	40′	8.1 c.c.
		S. I.$_1$ 6.3 ,,	,,	6.05 ,,
		S. I.$_2$ 9.5 ,,	,,	9.35 ,,
CO_2	1.10	L. I. 9.2 ,,	,,	4.6 ,,
		S. I.$_1$ 5.2 ,,	,,	3.1 ,,
		S. I.$_2$ 10.2 ,,	,,	6.4 ,,
Coal gas	2.5	L. I. 9.2 ,,	,,	8.3 ,,
		S. I.$_1$ 7.1 ,,	,,	6.9 ,,
		S. I.$_2$ 9.3 ,,	,,	8.5 ,,
Air + 2 gtt. ol. car. and ol. ol. in each chamber	3.0	L. I. 7.1 ,,	,,	7.8 ,,
		S. I.$_1$ 8.4 ,,	,,	8.8 ,,
		S. I.$_2$ 9.8 ,,	,,	10.4 ,, [1]
CO_2 + oil remaining	3.55	L. I. 7.5 ,,	,,	3.6 ,,
		S. I.$_1$ 8.1 ,,	,,	4.5 ,,
		S. I.$_2$ 13.3 ,,	,,	6.3 ,, [2]
Coal gas	4.55	L. I. 7.9 ,,	,,	8.3 ,,
		S. I.$_1$ 7.4 ,,	,,	8.2 ,,
		S. I.$_2$ 9.9 ,,	,,	10.3 ,, [3]

Note.—Circulation was normally active at the end of observation; peristalsis occurred when the gut was distended.

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[1] Very strong peristalsis during this period. Intestine knotted on each side of an inflated portion.

[2] Great amount of secretion, except in L. I., made estimation difficult, though it was accomplished satisfactorily. Great peristalsis. Secretion easily dealt with.

[3] Peristalsis in interval very active.

Experiment II.

A variation was made in this experiment by injecting subcutaneously thirty grains chloral hydrate, and so obviating the necessity for the use of æther, which is by nature an antispasmodic. The experiment lasted between four and five hours. Asafœtida was also substituted for ol. caryoph., two grains of the substance emulsionised being injected into the lumen of the intestine itself. Sulphuretted hydrogen was collected and estimated over water saturated with the gas.

Large intestine 5 inches from cæcum; two portions of small intestine isolated for examination, 10 inches of ileum, 12 inches of jejunum.

Cat (Healthy Small Female).

Gas.	Time.	Injected.	Time after.	Estimated.
H_2S	12.5	L.I. 3.0 c.c. $S.I._1$ 5.2 ,,	40′ ,,	2.2 c.c. 4.4 ,,
H_2S + asaf. 2 gtt. into L.I. and $S.I._1$	1.5	L.I. 2.4 ,, $S.I._1$ 5.2 ,,	,, ,,	1.6 ,, [1] 3.8 ,,
H_2S + asaf. remaining . .	2.0	L.I. 7.0 ,, $S.I._1$ 5.0 ,,	,, ,,	5.7 ,, [2] 4.7 ,,

[1] Respirations 20.

[2] Heart's impulse hardly perceptible

Synopsis of Experiments—

Experiment.	Gas introduced. Intestine with or without Carminative.	Part and Length of Intestine.	Atmospheric Air.			
I.–III.	Small int. No C.[1] . . .	Duodenum and ileum, 10 inches.	12 per cent. absorbed.			
	,, + Ol. caryoph. . .					
			Injected.[2]	Estimated.	Time.	Difference.
			c.c.	c.c.		
IV.	Small int. No C. . . .	Duodenum and ileum, 10 inches.	8.8	8.6	30′	− .2
	,, + Ol. caryoph. . .		...	...	...	...
			10.2	9.8	30′	− .4
V.	Small int. No C. . . .	...	11.1	11.0	30′	− .1
	,, + Ol. caryoph. . .	...	7.4	8.4	30′	+1.0
VI.	No. 1. Small int. No C. . .	Ileum, 10 inches.	5.7	5.6	45′	− .1
	,, ,, + Ol. caryoph.		7.9	9.3	60′	+1.4
	No. 2. Small int. No C. . .	Jejunum and ileum, 10 inches.	6.7	6.7	...	= .0
	,, ,, + Ol. caryoph.		8.8	9.4	...	+ .6
VII.	No. 1. Small int. No C. . .	Ileum, 10 inches.	6.3	6.05	40′	− .25
	,, ,, + Ol. caryoph.		8.4	8.8	...	+ .4
	No. 2. Small int. No C. . .	Ileum and jejunum, 10 inches.	9.5	9.35	40′	− .15
	,, ,, + Ol. caryoph.		9.8	10.4	...	+ .6
VIII.	No. 1. Small int. No C. . .	Ileum, 12 inches.	12.7	13.2	45′	+ .5
	,, ,, + Ol. caryoph.		8.7	8.7	45′	= .0
	No. 2. Small int. No C. . .	Jejunum and duodenum, 12 inches.	13.1	12.2	...	− .9
	,, ,, + Ol. caryoph.		12.0	11.9	...	− .1
IX.	No. 1. Small int. No C. . .	Ileum, 12 inches.	5.9	5.8	45′	− .1
	,, ,, + Ol. caryoph.		9.8	10.6	...	+ .8
	No. 2. Small int. No C. . .	Jejunum and duodenum, 12 inches.	...	...	...	...
	,, ,, + Ol. caryoph.		...	...	...	...
X.	No. 1. Small int. No C. . .	Ileum, 12.5 inches.	...	...	...	...
	,, ,, + Ol. caryoph.		...	...	...	...
	No. 2. Small int. No C. . .	Jejunum and duodenum, 10 inches.	...	...	...	...
	,, ,, + Ol. caryoph.		...	...	...	...
XI.	Small int. No C. . . .	Jejunum, 10 inches.	...	...	...	...
	,, + Asafœtida . .		...	...	...	...
XII.	Small int. No C. . . .	Jejunum, 8 inches.	8.0	8.5	40′	+ .5

[1] C. stands for carminative.
[2] The quantity of gas introduced is given in c.c.

—on Small Intestine.

Hydrogen.				Carbonic Acid Gas.				Coal Gas.				Carburetted Hydrogen.				Sulphuretted Hydrogen.			
8 per cent. absorbed.				12.5 per cent. absorbed.				... ...				... ...				... ...			
Injected.	Estimated.	Time.	Difference.	Injected.	Estimated.	Time.	Difference.	Injected.	Estimated.	Time.	Difference.	Injected.	Estimated.	Time.	Difference.	Injected.	Estimated.	Time.	Difference.
c.c.	c.c.			c.c.	c.c.			c.c.	c.c.			c.c.	c.c.			c.c.	c.c.		
10.0	10.0	30′	=.0	10.0	9.4	30′	- .6	...	...	...	...	...	...	...	...	...	...	...	...
10.2	10.2	30′	=.0	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10.0	9.7	30′	-.3	9.8	8.8	30′	-1.0	...	...	...	...	...	...	...	...	...	...	...	...
10.2	10.2	30′	=.0	11.2	10.6	30′	- .6	...	...	...	...	...	...	...	...	...	...	...	...
				{ 12.6	6.0	...	-6.6	...	...	...	...	...	...	...	...	...	...	...	...
9.7	9.2	...	-.5	} 10.2	5.7	...	-4.5	...	...	...	...	...	...	...	...	...	...	...	...
9.0	8.8	60′	-.2	7.9	6.1	90′	-1.8	...	...	...	...	...	...	...	...	...	...	...	...
10.7	10.5	40′	-.2	7.4	6.6	60′	- .8	...	...	...	...	...	...	...	...	...	...	...	...
5.5	5.2	60′	-.3	6.3	4.8	90′	-1.5	...	...	...	...	...	...	...	...	...	...	...	...
8.2	8.0	40′	-.2	8.1	5.8	60′	-2.3	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	5.2	3.1	40′	-2.1	7.1	6.9	40′	- .2	...	...	...	...	...	...	...	...
...	...	...	...	8.1	4.5	40′	-3.6	7.4	8.2	40′	+.8	...	...	...	...	...	...	...	...
...	...	...	...	10.2	6.4	40′	-3.8	9.3	8.5	40′	- .8	...	...	...	...	...	...	...	...
...	...	...	...	13.3	6.3	40′	-7.0	9.9	10.3	...	+.4	...	...	...	...	...	...	...	...
...	...	...	...	9.7	7.3	45′	-2.4	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	8.8	2.8	60′	-6.0	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	13.8	10.1	45′	-3.7	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	11.0	3.4	60′	-7.6	...	...	...	...	...	...	...	...	...	...	...	...
												{ 8.6	8.9	45′	+ .3	...	...	...	...
...	...	...	...	6.4	4.5	50′	-1.9	...	...	...		} 6.1	6.2	50′	+ .1	...	...	...	...
...	...	...	...	8.2	5.0	35′	-3.2	...	...	...	...	7.4	7.4	50′	= .0	...	...	...	...
												{ 11.1	10.4	45′	- .7	...	...	...	...
...	...	...	...	11.2	7.0	50′	-4.2	...	...	...		} 10.0	10.0	...	= .0	...	...	...	...
...	...	...	...	12.3	9.5	35′	-2.8[1]	...	...	...	...	11.1	11.1	...	= .0	...	...	...	...
...	...	...	...	8.2	5.0	60′	-3.2	...	...	...	...	9.1	7.6	60′	-1.5	...	...	...	...
...	...	...	...	10.4	6.3	...	-4.1	...	...	...	...	12.1	12.7	60′	+ .6	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	5.7	5.7	60′	= .0	...	...	...	...
...	...	...	...	5.4	4.4	10′	- 1.0[2]	...	...	...	...	4.7	4.9	60′	+ .2	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5.2	4.4	40′	- .8
...	...	...	...	...	...	...	...[3]	...	...	...	...	...	...	...	...	{ 5.2	3.8	40′	- 1.4
																} 5.0	4.7	40′	- .3
...	...	...	...	7.3	6.5	40″	- .8[1]	...	...	...	...	...	...	...	...	...	...	...	...[5]

[1] Much secretion vitiated result.
[2] Animal died during this experiment.
[3] Circulation almost ceased as poisoning from H_2S occurred.
[4] Much greater absorption of CO_2 by large intestine in this instance.
[5] Animal died, apparently owing to great absorption of H_2S, which occurred from large intestine.

Synopsis of Experiments on—

Experiment.	Stomach or Large Intestine, with or without Carminative.	Length of Intestine.	Atmospheric Air.			
I.–III.	Stomach. No C. . . . . . „ + Ol. caryoph. . .	... ...	Usually no difference. Occasionally considerable disappearance. Result is, however, questionable.			
			Injected.	Estimated.	Time.	Difference.
			c.c.	c.c.		
IV.	Large int. No C. . . . . „ + Ol. caryoph. . .	6.0 inches	8.3 11.0 10.2	8.3 10.5 9.8	30′ 30′ 30′	=.0 – .5 – .4
V.	Large int. No C. . . . . „ + Ol. caryoph. . .	6.5 inches	10.4 11.2	10.3 11.4	30′ 30′	– .1 +.2
VI.	Large int. No C. . . . . „ + Ol. caryoph. . .	7.0 inches	3.9 8.2	3.8 8.2	45′ 60′	– .1 =.0
VII.	Large int. No C. . . . . „ + Ol. caryoph. . .	6.5 inches	8.4 7.1	8.1 7.8	40′ 40′	– .3 +.7
VIII.	Large int. No C. . . . . „ + Ol. caryoph. injected into stomach .	7.0 inches	9.7 8.0	10.2 8.0	45′ 45′	+.5 +.0
IX.	Large int. No C. . . . . „ + Ol. caryoph. . .	7.0 inches	8.5 ...	8.6 ...	45′ ...	+.1 ...
X.	Large int. No C. . . . . „ + Ol. caryoph. injected into stomach .	6.0 inches	... ...	... ...	... ...	... ...
XI.	Large int. No C. . . . . „ + Asafœtida . .	6.0 inches	... ...	... ...	... ...	... ...
XII.	Large int. No C. . . . . „ + Asafœtida . .	6.0 inches	8.0 ...	8.0 ...	40′ ...	=.0 ...

—Large Intestine and Stomach.

Hydrogen.				Carbonic Acid Gas.				Coal Gas.				Carburetted Hydrogen.				Sulphuretted Hydrogen.			
...	...			Some decrease.				...	...			...	...			...	...		
...	...			Some decrease.				...	...			...	...			...	...		
				Estimation difficult.															
Injected.	Estimated.	Time.	Difference.	Injected.	Estimated.	Time.	Difference.	Injected.	Estimated.	Time.	Difference.	Injected.	Estimated.	Time.	Difference.	Injected.	Estimated.	Time.	Difference.
c.c.	c.c.			c.c.	c.c.			c.c.	c.c.			c.c.	c.c.			c.c.	c.c.		
10.0	11.5	30′	+1.5	10.2	9.9	30′	− .3	...	...	...	...	...	...	...	...	...	...	...	...
9.9	9.7	30′	− .2	10.3	9.8	30′	− .5	...	...	...	...	...	...	...	...	...	...	...	...
10.7	10.7	30′	= .0	11.3	6.0	30′	−5.3	...	...	...	...	...	...	...	...	...	...	...	...
10.7	10.4	30′	− .3	10.2	5.8	30′	−4.4	...	...	...	...	...	...	...	...	...	...	...	...
3.7	3.5	45′	− .2	6.7	4.6	90′	−2.4	...	...	...	...	...	...	...	...	...	...	...	...
8.9	7.4	40′	−1.5	7.3	5.7	60′	−1.6	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	9.2	4.6	40′	−4.6 [2]	9.2	8.3	40′	− .9	...	...	...	...	...	...	...	...
...	...	...	...	7.5	3.6	40′	−3.9	7.9	8.3	40′	× .4	...	...	...	...	...	...	...	...
...	...	...	...	7.4	5.8	45′	−1.6	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	8.1	2.0	60′	−6.1	...	...	...	...	...	...	...	...	...	...	...	...
				6.3	4.7	50′	−1.6 [3]					6.9	7.1	45′	+.2	...	...	...	...
...	...	...	...	9.5	6.3	35′	−3.2	...	...	...		7.15	7.15	45′	= .0	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	9.2	9.3	50′	+.1	...	...	...	...
...	...	...	...	8.0	4.0	40′	−4.0	...	...	...	...	6.5	6.5	60′	= .0	...	...	...	...
...	...	...	...	9.5	8.6	40′	− .9 [4]	...	...	...	...	7.6	7.6	60′	+.8	...	...	...	...
...	...	...	...	3.7	3.3	40′	− .4 [5]	...	...	...	...	...	...	...	...	3.0	2.2	40′	− .8 [6]
																2.4	1.6	40′	− .1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7.0	5.7	40′	−1.3
...	...	...	...	6.4	3.9	40	−2.5	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	9.0	6.0	60	−3.0	...	...	...	...	...	...	...	...	...	...	...	...

[1] Extensive secretion which occurred in this case may account for irregular result.
[2] *Ibid.*
[3] Both with ol. caryoph.; more added before second estimation.
[4] Cat died during this estimation.
[5] Cat died apparently from absorption of H_2S.
[6] The cat moribund from H_2S.

Brief Statement of Results.

Atmospheric Air.—Small Intestine.—The results were negative, but little if any absorption occurring before the carminative, and no apparent increase in absorption after its use.

The same may be said of the large intestine.

Reckoning Experiments iv., v., vi., vii., and ix. on the small intestine, the disappearance without carminatives was 1.6 per cent., whilst with them there was a slight increase in the volume of gas returned (estimated at room temperature) as contrasted with the total introduced.

Hydrogen.—Small Intestine.—Before carminatives (four estimations) disappearance averaged 1.5 per cent.

After carminatives (ol. caryophylli) disappearance averaged in four experiments 3.1 per cent.

Large Intestine (three estimations).—In one case a considerable increase in the gas returned was noted, 1.5 c.c. In the other two an equal return or a slight disappearance took place.

After ol. caryophylli there was in two cases a slight diminution of volume, and in the third (Experiment vi.) a very considerable reduction.

Carbonic Acid Gas.—We have already stated that approximate allowance has been made in the figures given for absorption of carbonic acid gas during estimation.

Small Intestine.—Experiments iv. to ix., inclusive of the first half of No. x., yield eleven estimations for the absorption of carbonic acid gas, and twelve for its absorption after the action of carminatives; ol. caryophylli being in each case employed.

In all cases a marked disappearance was recorded before the action of ol. caryophylli; this disappearance amounted to no less than 26 per cent. of the total injected.

After the employment of carminatives (oil of cloves), an average disappearance of 41 per cent. was recorded. It is necessary here to draw attention to the fact that after a large proportion of the injection of oil of cloves in emulsion very abundant secretion resulted, and this secretion may have been in part answerable for the disappearance of this gas.

Large Intestine.—From an examination of seven experiments without and seven with oil of cloves, we obtained an average percentage reduction of the volume of the returned gas amounting to 32.4 in the former and 35.9 for the latter, a difference which does

not run by any means parallel with the estimations made with the small intestine.

Coal Gas.—We were not able to satisfy ourselves that any disappearance took place in the volume of coal gas admitted to the small or large intestine after the administration of clove oil; on the contrary, as estimated at room temperature, a slight increase in volume was noted, in place of the trifling disappearance which seemed to occur before the carminative.

Carburetted Hydrogen.—Small Intestine.—Six estimations were made before oil of cloves, and four after it. The former yielded 3.7 per cent., a disappearance somewhat beyond the limits of probable error, whilst the latter gave an increase of 2.2 per cent. on the total injected. The large intestine gave a somewhat parallel result.

Sulphuretted Hydrogen disappears to a large extent; its estimation was made over saturated water. In two instances we have seen animals die after its introduction into the intestine, one of these being distinctly convulsed.

Asafœtida was the carminative employed in the Experiment xii. in the schedule. It had no marked effect in increasing absorption before its second administration. More than 15 per cent. of the gas disappeared in the course of forty minutes.

Conclusion.

When atmospheric air, hydrogen, coal gas, and carburetted hydrogen were injected into the intestine, little or no absorption occurred in our experiments, and the addition of carminatives did not appear to increase absorption; on the contrary, in some experiments a slight increase in the volume of the returned gas occurred. As no analysis of the returned gas was made, we cannot state positively what the cause of this increase may have been.

In the case of carbonic acid gas and sulphuretted hydrogen the results were very different, and a considerable amount of the gas injected into the intestine disappeared. As both these gases are very soluble in water and in alkaline solutions, this disappearance may have been partly due to solution of the gas in the intestinal secretion, but in the case of sulphuretted hydrogen the symptoms of poisoning which accompanied its disappearance showed that it had undergone absorption into the circulation; and we may fairly

conclude that disappearance of carbonic acid was chiefly due to absorption likewise. The effect of carminatives appeared to be to increase the amount of carbonic acid gas absorbed, but not that of sulphuretted hydrogen. As the amount of secretion caused by the introduction of oil of cloves was great, the fact that the disappearance may have been owing to a solution, and not entirely to a physiological absorption, is not to be lost sight of. Whatever the explanation may be, the increase of secretion indicates that advantage is to be gained from the prescription of carminatives together with purgatives in everyday practice.

The rapid absorption of sulphuretted hydrogen in the intestine —so rapid as to give rise to fatal poisoning—is very interesting from a clinical point of view, inasmuch as this is one of the gases occasionally formed from the intestine in cases of disordered digestion. After its absorption the gas is carried by the blood to the lungs, and is there eliminated so rapidly, that unless the venous blood be very lightly charged with it, almost the whole of it escapes in the breath, and too little of it reaches the nerve centres and the systematic circulation generally to produce any toxic symptoms.[1] Indeed, Claude Bernard states that although sulphuretted hydrogen kills animals rapidly when absorbed by the lungs, yet it may be introduced with impunity into the veins, the subcutaneous cellular tissue, and the intestinal canal, and that no malaise is observed in the animal experimented upon.

But this can only be true when the quantity injected is small, for Orfila[2] observed that both gaseous sulphuretted hydrogen and a solution of it in water when injected into the large intestines of rabbits and horses caused the death of these animals in less than a minute. Although sulphuretted hydrogen is frequently found in the intestine in cases of dyspepsia, as is evidenced by the taste of rotten eggs, of which the patient complains, or even by the odour of the eructations, yet the quantity formed is rarely sufficient to produce serious symptoms. Occasionally, however, such a rapid and extensive formation occurs that the whole of the quantity absorbed by the intestine cannot be eliminated from the lungs, and serious, or even approaching fatal, poisoning may ensue. We have found three cases of this sort on record. In one of them, described by Senator,[3] the symptoms consisted in giddiness and collapse; and

[1] *Leçons de Pathologie expérimentale*, 439.
[2] *On Poisons*. Waller's translation, 2nd edit., vol. ii. p. 376.
[3] Senator, *Berlin. klin. Wochensch.*, 1868, No. 24.

in another case, mentioned by Betts, in which the sulphuretted hydrogen appears to have been mixed with acetone and ammonia, the pulse and respiration were both rapid, the face red, and the patient insensible and delirious.

In conclusion, we may shortly recapitulate the chief results of this paper by saying that we have found little or no absorption of gas from the intestine except in the case of carbonic acid and sulphuretted hydrogen. Carminatives did not appear to accelerate absorption except in the case of carbonic acid. The utility of carminatives in flatulence appears to be rather due to their effect upon the movements of the intestine than to their causing an increased absorption of gas from it. The carminative chiefly used in our experiments, oil of cloves, caused a marked increase in the secretion of the intestine, and this action may be one of the factors in the utility of carminatives as an adjunct to purgatives.

The fact that sulphuretted hydrogen may be absorbed from the intestine so rapidly as to produce fatal poisoning, indicates the necessity for care in its administration per rectum in the way recently suggested as a cure for phthisis.

ON CONSTIPATION AND DIARRHŒA.

A paper read before the Brixton Medical Society, at 125, *Kennington Park Road, on Thursday, Jan.* 16, 1896.

(Reprinted from the *Lancet*, May 30, 1896.)

THE subject of Constipation and Diarrhœa is one that is interesting to every medical man, because, I suppose, there are no other ailments for which he is so often consulted. Constipation especially is so exceedingly common in civilised communities, that I think we ought hardly to look upon it as a disease. We find it amongst the strongest, the healthiest, and the longest lived of our people, and although they suffer from it, and therefore ask for aid from medical men, it is probable that we should regard constipation really as the reaction of a healthy organism to unfavourable surroundings. The unfavourable, or unnatural, surroundings may be said to be, too soft food, too little water, or too little exercise There are no doubt many other conditions which tend to bring about constipation, but these three may, I think, be looked upon as the chief factors in the production of chronic constipation. Primitive communities take food which is not only rather hard and generally imperfectly cooked, but leaves a considerable amount of indigestible residue. In our school-days we used to read how Cæsar and his troops carried with them little hand-mills and bags of corn or of wheat. The corn, or wheat, was put into the hand-mill and roughly ground. In this way the grain was imperfectly broken up, and so taken by the soldiers. Amongst uncivilised communities at the present day it may be simply pounded. In civilised countries, however, we have mills which not only grind the corn very finely, but separate the outer and more indigestible part of the grain from the starch which constitutes the interior of the grain. We thus get rid, by the perfection of our machinery, of those parts of the grain which would leave in the bowel undissolved residues, and which would act thereby as a mechanical stimulus to the

peristaltic action of the bowels. Similarly in regard to fruits and vegetables; we are accustomed to take them, not in their crude state, but well cooked, and if there are any indigestible parts either in the vegetables or in the fruits, they are generally removed.

Soft food, then, is one of the first causes of constipation, and in trying to treat constipation, one of the first means to which we have recourse is to bring our patients back to the conditions under which less civilised nations usually live. We advise them to take bread either consisting of whole meal or with a greater or less admixture of bran. We advise them to take vegetables in abundance, either cooked, such as cabbage, spinach, broccoli, Brussels sprouts, cauliflower, carrots, turnips, parsnips, and the like, or we advise them to take vegetables such as tomatoes, celery, and so on, raw as well as cooked. In America it is very common indeed for people to begin or finish their breakfast with a slice or two of raw tomato or a slice or two of melon, and these fruits very often are sufficient to keep the bowels open. In this country we not infrequently recommend patients to take in the morning a raw apple or two, suck an orange or two, or eat a fig on an empty stomach before breakfast, and here also we very frequently find that we get the desired result. One of the most common of the fruits we prescribe is stewed prunes, and frequently these keep the bowels open, or a stewed or roasted apple or two may do so also. Many patients, however, find that even stewed prunes are insufficient to keep the bowels open, and in such cases one may succeed in getting a regular movement by simply taking some senna leaves, tying them in a muslin bag, and putting them into the pan beside the prunes to be stewed. This very simple plan has, in some cases that I have had under treatment, succeeded when the ordinary method of just recommending stewed prunes has proved insufficient.

Fruits also contain, as a rule, salts of vegetable acids. Many of them also contain sugars, and both the salts and sugars are of importance as laxatives. In the case of a fig, we find that there are three kinds of laxative properties: there is (1) the mechanical irritation due to the altogether indigestible seeds; (2) the stimulus given by the vegetable salts contained in the fig; and (3) the stimulus given to the bowel by the sugars.

Sugars in themselves are useful laxatives, and golden syrup, honey, or still better, perhaps, the old-fashioned black treacle, are

very useful laxatives, and they may be given—at least the syrup and treacle may be given—along with oatmeal porridge in the morning. Honey, treacle, or syrup may be given spread upon bread, or the latter two may be mixed with the bread to form ginger-bread; and in all these ways they prove very useful laxatives. Vegetable jellies taken with bread are less efficient, but vegetable jams are very useful, because in them we find a mechanical stimulus is given by the seeds or by the skins which the jams contain. A very favourite addition to the breakfast-table is marmalade, which contains vegetable salts, sugar, and also the hard skin of the orange cut up into small pieces, which are rather indigestible and give a mechanical stimulus to the bowel.

Water, insufficient in *quantity*, or abnormal in quality, is also a cause of constipation. We find that civilised people are very often in the habit, as it were, of cheating the natural desire for water by taking wine, and many people, especially ladies, are in the habit of taking less water than they like, because if they drink more water it will pass through the kidneys, and the exigencies of society may prevent them from emptying the bladder as frequently as they would wish, and, therefore, they get into the habit of taking much less water than is advisable. A dryness of the bowel constantly results from this: the fæces become drier and harder, and so constipation occurs. This constipation may frequently be lessened by simply allowing the patient to drink a large tumblerful of hot water, or even of cold water, according to the season of the year, on rising in the morning, and sometimes a similar tumblerful of water taken just before going to bed, aids the action of the bowels.

A wrong *quality* of the water is a frequent cause of constipation, and people living on a chalky soil, and drinking hard water, are very apt to suffer from this trouble. Where this is the case, the patient should drink some of the ordinary bottled waters, such as soda water, potash water, or aërated waters generally. Not only should they drink this, but they should have their tea made with these waters instead of with the ordinary chalky water, as the quantity of lime in the water taken as tea is sufficient in some people, if the water be very chalky, to keep up the constipation, which will be relieved if the water taken in the form of tea be free from lime. It is very difficult for patients supplied with hard water to get their food cooked with water free from lime, and the

only thing one can do is to advise them, if possible, to secure soft water for cooking purposes, for they will not use bottled waters on account of the expense.

Another very important point in the cure of constipation is habit, and this habit is also of great importance in regard to the production of constipation. The bowels usually tend to act once in twenty-four hours, and generally nearly at the same time in the day. If a person who is accustomed to evacuate the bowels regularly omits to do so in consequence of having to hurry away somewhere, or having some engagement which prevents him from going to the closet at the accustomed hour, he is apt to break the habit, and it is sometimes much more easy to lose the habit than to regain it. It is very essential that the patient should go to the closet as nearly as possible at the very minute by the clock, and he should, if possible, go after breakfast; for, as Cash has shown, the introduction of food into the stomach, especially after the long fast during the night, tends to cause a peristaltic movement of the intestines, which brings some of the fæcal matter from the sigmoid flexure down into the rectum, and tends to cause an evacuation. However, this regular time is in some cases impracticable in the morning on account of the calls of business, which make the man leave his house quickly to catch a train to the city, or from other reasons. In such cases the bowels should be evacuated at bedtime, or at some hour of the day when regularity can be secured. In cases where the patient suffers from hæmorrhoids or a tendency to prolapse it is much better that the evening should be selected, so that the bowels shall be evacuated just before going to bed, because in persons suffering from hæmorrhoids or a tendency to prolapse there is apt to be a feeling of great discomfort consecutive to the movement of the bowels, and if the movement occurs in the morning, they suffer from this discomfort the whole of the day. If the bowels are emptied just before retiring to bed, they can wash the parts, return the hæmorrhoids or bowel, then go to bed, lie quiet and comfortable, and in the morning all trace of discomfort has passed away.

Exercise has a good deal to do with the movements of the bowels. Deficiency of exercise tends to cause constipation, partly, I believe, because the bowels do not get a mechanical stimulus applied to them by the contraction of the abdominal muscles. So that, as a rule, we advise our patients to take exercise; but a great many people will not take exercise, and I think a number of people can-

not do so. In such cases we may supply its place by the use of massage, and massage to the abdomen certainly will counteract the tendency to constipation. In many persons the advantage of massage over ordinary exercise is, that in massage the stimulus is applied not merely to the abdominal muscles themselves, but really also to the bowels below, and it may be applied in various ways. There is first of all the massage which the patient himself may use. In sitting at stool and trying to elicit an evacuation he may simply press with the ball of the left thumb, downward along the course of the descending colon and sigmoid flexure, pressing pretty deeply in when he comes nearly to the pubic arch. This action is useful even during the evacuation. Another action the patient may practise himself is rubbing the bowel gently onwards in the direction of the hands of a watch, and sometimes it is of advantage to use the fingers with a rotatory motion from the right iliac fossa upwards along the course of the ascending colon, across the transverse, and then down the descending colon and sigmoid flexure.

There is one class of patients in whom I think exercise is disadvantageous. You will frequently find delicate women, especially those who have got some sort of ovarian or uterine irritation, who tell you that the more exercise, particularly walking exercise, they take, the more obstinate the constipation becomes, whereas when they lie quiet they are perfectly well. In such cases, I believe, there is a reflex inhibition of the peristaltic movements of the bowels from the irritated ovaries or uterus, and in some of these patients you may get an evacuation occurring from a remedy which is one of the last, possibly, you would think of employing,—viz. opium. My attention was first directed to this by the case of a woman who was under the care of my friend Dr. Littlejohn. The bowels were obstinate, and my friend prescribed half-a-grain of opium so as to try to lessen the pain which she was suffering from an inflamed ovary. To his astonishment, she got after the opium a natural evacuation, which she had not had for a long time before. Following on this, I made a somewhat extensive trial amongst my out-patients at St. Bartholomew's Hospital, but the results I got were very uncertain. In some cases it acted, but in others there was no action at all. It is quite possible—indeed it is probable—that some of the cases were unsuitable for it. In one private case I did not know exactly what dose to give, and I prescribed one minim of the tincture of

opium every night. A week afterwards I had a report from the patient's husband to say his wife was no better. I replied, "double the quantity." In a few days the report came, "she is rather worse." I then wrote to say, "give her half the first dose." Three or four days afterwards I had a letter to say that the last medicine acted well, if anything a little too violently. I have never been able to make up my mind as to whether this result was due to suggestion, like the aperient action of a bread pill, or was actually due to the action of the drug. I am inclined to think it was actually due to the drug, because the suggestion had been clearly applied to her mind by the one minim and the two minims, and these did no good first of all and later did harm, while the half-minim dose caused an active evacuation of the bowels. At first it seems an absurdity to ascribe this action to the opium, but when one comes to think of the complex nature of the innervation of the intestine, where there are at least two different systems of nerves—one which stops movement in the intestine, and another which increases movement—one sees that it comes to be simply a question of a shifting of the action of a very delicate balance.

Another point that I wish to mention is the action of the floor of the pelvis in defæcation. In defæcation the contents of the intestine are passed onwards by its peristaltic movement, but this action is aided by the abdominal muscles, which tend to press out the contents of the rectum in much the same way as they tend to press out the child in child-birth. But we all know that in child-birth the head of the child is driven, not against the opening of the vulva, but behind it, so that the head of the child must be turned forward by the pressure of the perineum, frequently aided by the hand of the accoucheur. In the same way the muscles of the abdominal wall will press the fæcal mass backwards, not directly towards the anus, but behind it, in a line that would almost strike the tip of the coccyx, and if the finger be placed under the tip during the effort of straining, this pressure is easily felt. Where the pelvic floor is very lax, as it is in women who have borne many children, you may find that the fæcal masses will accumulate in the rectum, and form there a big accumulation, and the floor of the pelvis is so loose that it will not press them forwards so as to evacuate them through the anus. One great hindrance to complete evacuation of the rectum is the position adopted in this country during defæcation, *i. e.* sitting upon what

is practically a chair with an opening in it. In nearly all other countries, and in all uncivilised places, where the bowels are moved in the open air, the position adopted is that of crouching, with the knees somewhat apart. This position tends to cause a certain amount of stretching of the floor of the pelvis, and to afford support to the fæcal mass as it is driven backwards by the action of the abdominal muscles. In cases where the patient must use the closet, a certain amount of tension is often imparted involuntarily to the pelvic floor by the patient leaning forwards at an acute angle. But this is not so good as the crouching position, and in patients who suffer from a lax condition of the pelvic floor it is advisable to tell

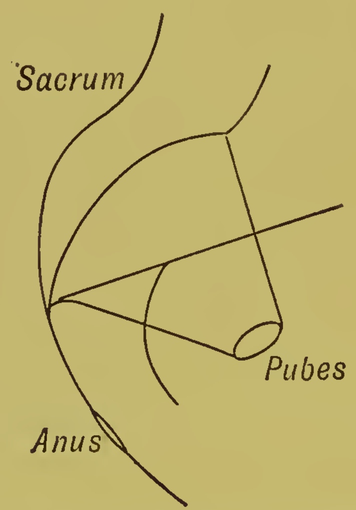


Diagram showing axis of pelvis and direction of pressure by abdominal muscles (after Cazeaux, Traité Théorique et Pratique des Accouchements).

them not to use the ordinary seat in the closet at all, but to keep a chamber-pot in the closet, and sit over it in the normal crouching attitude. Sometimes great help is afforded by the patient putting the fingers just beside and a little in front of the coccyx, so as to support the pelvic floor and give a little pressure to the fæcal masses, so that they may pass forwards through the anus in very much the same way as the accoucheur would support the head during parturition.

In some cases hydropathic treatment is very useful. The essentials of the hydropathic treatment are simply the application of wet compresses to the abdomen two or three times a day and sitz baths, cold in the summer and the chill taken off in winter. These must be followed or accompanied by exercise and drinking

water, so that it is almost impossible to get the full effect of the therapeutic measures in a patient who is being treated at home.

Time would fail me to discuss the question of what medicines given by the mouth are best in constipation, of purgatives, of laxatives, of breakfast-pills, of dinner-pills, etc., and, moreover, they are most fully discussed in text-books and papers innumerable, and I shall, therefore, pass them over and proceed to discuss some points in regard to diarrhœa. I shall also pass over the ordinary diarrhœa due to irritation of the intestine by the intestinal contents or by the decomposition of food, etc. I will simply draw attention to one method of stopping diarrhœa which is applied in various ways when the diarrhœa is due to decomposition of the intestinal contents by bacteria. The decomposition may be arrested and the diarrhœa stopped by simply starving the bacteria out. Thus, where you find bacilli thriving upon certain diets you put the patient on an entirely different diet, and so get rid of the bacteria which have been living upon other foods. If a patient has been on a flesh diet and that has not succeeded, you put him on a farinaceous diet. Again, you may find that in certain children a farinaceous diet, or even a milk diet, is not successful, and you then put them on a meat diet, raw-meat juice, etc., and in this way starve out the bacteria which were causing decomposition of the milk or farinaceous food, so that when the ordinary food is again resumed the decomposing bacteria have been starved out and no decomposition will occur in the intestine.

I would also draw your attention to the excellent results which follow treatment by an entirely milk diet, particularly in patients coming from India and Afghanistan with chronic diarrhœa, and where every other method is utterly useless. As my friend Sir Joseph Fayrer has shown, these cases must be treated just as one would treat a case of typhoid fever, viz. by milk, and nothing else whatever in the way of food. In some cases the patient even lays on flesh and is able to attend to his work, but this is not the general rule, as they usually have to be kept quiet in bed while they are on the milk diet.

I would next draw attention to an obstinate form of diarrhœa met with in connection with irritability of the sigmoid flexure. It is a form of diarrhœa that is very often known as "morning diarrhœa." The patient has to get up very early in the morning, and perhaps has three to six movements before 11 a.m. After that

he is pretty free, and probably after mid-day he has no action at all until next morning. This form of diarrhœa is sometimes not so severe, and occurs only in the shape of one movement just after breakfast, followed by one or two loose motions within the next hour or so, but both the severe form and the mild are by no means amenable to treatment. We give our patients opium, astringents, and sedatives such as bismuth, until we are tired, and yet by the simple means of regulating the diet results are obtained which cannot be got by ordinary remedies. The remedy is this*:* Tell them to take no liquid after five o'clock in the afternoon. It would seem that in such cases liquid taken after five or six o'clock tends to accumulate in the stomach or in the bowel, and it acts just in the same way as if the patient were to take a large dose of Carlsbad salts in the morning. In some of these cases dilatation of the stomach is present, but I do not think it is present in all. In all the cases I have met with I have got distinct improvement, and in many complete cure, by this simple regulation of taking no liquid after 5 p.m.

There is another form of diarrhœa the cause of which, I think, is often unobserved, and that is diarrhœa of a chronic irritating character; small motions, but numerous and often accompanied by tenesmus, which is due to a prolapse of the sigmoid flexure into the rectum. As you know, the rectum is pretty firmly fixed to the bones of the pelvis, especially to the sacrum, so that although prolapse of the rectum through the anus is common in children, prolapse of the rectum is by no means very common in adults. But prolapse of the sigmoid flexure into the rectum is by no means uncommon in adults, and it sometimes gives rise to constipation, but frequently causes chronic diarrhœa. My attention was drawn to this very markedly in a patient whom I saw some years ago—a tea-planter who had come from Assam. He had suffered from chronic diarrhœa for from six months to a year before I saw him. The whole of his trouble dated from an attack of violent constipation which had lasted many days. To relieve this he took a strong purgative, and from the moment that this acted he had suffered from diarrhœa. All the remedies he tried had failed. On examination by the bowel I found almost exactly the same condition as you would find in a child with a prolapsed rectum, only in this case the prolapse was as far up the rectum as one could reach with the finger. I found high up in the rectum regular bags of mucous membrane hanging down, and in the middle of these bags

one could feel the opening into the sigmoid flexure. This man was treated chiefly by water enemata, to keep the contents of the sigmoid flexure soft, and by the application of catechu, so as to exercise an astringent action upon the rectum. By carefully regulating the diet, so as to avoid hard irritating substances coming down from the sigmoid flexure, by keeping the fæcal masses in the sigmoid flexure quite soft so that there should be no mechanical pressure, and by injecting an astringent lotion (about two ounces of water to a drachm of tincture of catechu) into the bowel after each motion, and retaining it as long as possible, the patient was completely cured of the diarrhœa in a few months.

There is one other cause of diarrhœa to which I must draw attention, and that is diarrhœa from malignant disease. The operation of examining the bowel is a disagreeable one both for the operator and for the patient, and for this reason it is frequently omitted. But in all cases of chronic diarrhœa I think it ought to be done. I have known several cases in which its omission has proved very disadvantageous to the patient. In one case which I have seen a woman had suffered from diarrhœa for two years. All that time she had been under constant treatment, but no examination of the bowel had been made, and I am sorry to say that when I did examine the bowel I found malignant disease, which rendered colotomy necessary in about ten days. Another patient came to me for neuralgia of the perineum, and there again I found malignant disease of the rectum. Yet another patient came to me who said she was suffering from a little bilious attack and tendency to constipation. She looked so well, and all her friends said she was so well, that I did not at once make an examination; but later she told me she was passing a little mucus occasionally tinged with blood, and therefore I made an examination and found malignant disease of the rectum. Perhaps I would hardly have laid such stress upon this, but just before I came here to-day I saw a poor woman who had come to me in very much the same condition and not suspecting anything, but on examination I found that there was malignant disease, and a colotomy was performed yesterday. In such cases colotomy is only capable of affording temporary relief. Whether, later, surgery will improve so far that the operation which has been done once or twice without much success will be successful one cannot say. I mean the operation of cutting a bit out of the bowel and sewing the two ends together. As a rule this has not been successful, but there is no reason why

it should not be successful ; and I think that if surgery advances in the next ten years as it has done during the last ten years, in all probability it will be successful, and that we shall save our patients' lives under circumstances where at present we are forced to say that the case is hopeless.

ON SOME FORMS OF DIARRHŒA, ESPECIALLY MORNING DIARRHŒA.

Read before the Nottingham Medico-Chirurgical Society, October 18, 1893.

(Reprinted from the *Quarterly Medical Journal*, January 1894.)

THE subject of diarrhœa is a very wide one and a very important one, for perhaps there is no other condition which gives rise to so much mortality. But the subject is so wide that I am unable to discuss anything like the whole of it to-night, and I therefore mean to restrict my remarks only to certain forms of diarrhœa. Nor do I mean even to take up the commonest and most important kinds of diarrhœa. I intend rather to take up certain forms which have not received very full notice in the text-books. More especially do I wish to direct your attention, first of all, to the form of diarrhœa called morning diarrhœa.

On looking through most of the standard text-books, I find that although its existence is mentioned in some of them, yet no special attention is directed to it. In his work on *Diseases of the Rectum*, published in 1871, Mr. Allingham[1] recognises morning diarrhœa as the earliest symptom in most cases of ulceration of the rectum, but notes that it is not always present. Lorimer[2] has made a similar observation. Chambers[3] and Annandale[4] describe cases cured by treatment of the ulcer. The existence of morning diarrhœa was recognised by Dr. Gueneau de Mussy.[5] He regarded sleep as an important factor in its causation. He did not, however, give any distinct account of the pathology of this symptom, but had observed it in cases of malaria and in cases of phthisis. In malaria he had cured it by quinine, and in phthisis by opium given just after dinner, again at bed-time, and again in the morning. Dr. Graves recommends as a mode of treatment

[1] Allingham, *Diseases of the Rectum*, 1871, chap. x. p. 152.
[2] Lorimer, *Lancet*, vol. ii. 1872, p. 804.
[3] Chambers, *Lancet*, vol. ii. 1872, p. 804.
[4] Annandale, *British Medical Journal*, December 21, 1872.
[5] Gueneau de Mussy, *Clinique Médicale*, Paris 1874, vol. ii. p. 119.

thirty minims of persesquinitrate of iron with infusion of calumba twice or thrice a day.[1]

I have not been able to come across any monograph on the subject of morning diarrhœa, excepting a thesis, *Diarrhée Matinale,* presented to the Faculty of Medicine by M. Auguste Chauvet in 1888. My own attention was first directed to the condition by the case of a patient who was sent to me in 1881, by my friend, Dr. Young, of Rome. This was a lady who had consulted him three years before for diarrhœa accompanied by intense pain. The motions sometimes amounted to as many as eight or nine, and these occurred almost exclusively during the forenoon, and chiefly between 8 and 10 a.m. The pain which accompanied the motion was sometimes so severe as to cause fainting, and the motions themselves were loose, and contained occasionally a little mucus and blood. On rectal examination Dr. Young found that there was an ulcer of an oval shape, and nearly one inch in diameter, situated on the posterior wall of the abdomen. Its edges were sharply cut, its margin slightly raised, and its surface covered with unhealthy pus, and it bled easily when touched. The treatment which was found most serviceable for this case was the local application of an ointment of calomel and opium for a day or two, followed up by an ointment of oxide of zinc and bismuth. Under this treatment the ulcer healed rapidly, but was liable to recur, and on one occasion, although it was completely healed, the diarrhœa continued. I then noticed tenderness over the sigmoid flexure, and concluded that there was probably a certain amount of ulceration present there also. This case, I think, may serve to give us an insight into the pathology of morning diarrhœa, although it is quite possible that this form of diarrhœa is not always dependent on the same cause, and there may be several modifications of it. We very frequently produce morning diarrhœa artificially by the administration either of a purgative pill over night, or by a large dose of black draught or purgative salts in the morning, or by pill and draught combined. A consideration of the *modus operandi* of these remedies may help us to understand the pathology of morning diarrhœa, and consequently lead us to a correct treatment. This is all the more necessary, because the patients who suffer from this affection are often troubled by it for years, and although it may not be dangerous

[1] *Graves' System of Clinical Medicine,* Dublin, 1843, p. 672; and Sydenham Society's edition, vol. ii. p. 258.

to life, it interferes seriously with their comfort and may interfere much with the performance of their duties. Morning diarrhœa is also troublesome to treat by drugs, for although it may be arrested by astringents, it is apt to return on the discontinuance of the remedies, and after a while the patients get tired of using them. In considering the mode of action of a black draught, and also that of a simple saline, such as Epsom salts, or one of the natural purgative waters, we have three factors, viz., (1) accelerated peristalsis; (2) diminished absorption; and (3) actual secretion of watery fluid by the intestinal wall. Many pharmacologists have denied this last factor, but the experiments of Moreau, repeated by Vulpian, and fully confirmed by Pye-Smith and myself, as well as by Hay, leave, I think, no doubt that saline purgatives produce profuse watery secretion from the intestine, as well as accelerated peristalsis and diminished absorption. The senna of the black draught and the colocynth and aloes of a purgative pill, on the other hand, produce purgation chiefly by accelerating peristalsis, so that the intestinal contents are hurried quickly along, and expelled before there has been time for the absorption of their watery constituents. The composition of the motions produced by such purgatives have been found to be almost exactly the same as that of the ordinary contents of the small intestine, so that the looseness of the motions, although it may be partly due to accelerated peristalsis of the small intestine, is chiefly due to the increased rapidity of passage through the large intestine.

If we take a purgative pill or a dose of compound liquorice powder, or a teaspoonful of extract of cascara sagrada at night, and a large draught of water, either hot or cold, next morning, we need not consider the effect of increased secretion as in the case of salines, but only that of accelerated peristalsis and of diminished absorption. During the hours of sleep the purgative probably lies in the stomach, or only proceeds some little way down the intestine, but on awaking, the movements of the alimentary canal which have been lessened during sleep, again become brisk, and being increased by the purgative, both it and the water are hurried along through the stomach and small intestine, and poured into the cæcum, which they will distend in the same way as an ordinary purgative injection does the rectum and sigmoid flexure. They will thus start increased peristaltic action in this part of the bowel, which continuing along the colon will hurry them on to the rectum, and they will then be evacuated by one or two loose motions.

According to M. Chauvet the causation of the loose motions in morning diarrhœa is much the same as that of the artificial diarrhœa which we have just been considering, but the part of the purgative is played by the contents of the stomach. He considers that in most cases the stomach is somewhat dilated, and the food, instead of being expelled through the pylorus a little at a time as it ought to be, lies in the dilated organ during the hours of sleep, and on awaking is poured out *en masse* into the small intestine, through which it quickly runs into the large intestine and on to the rectum in the same way as the purgative.

It is not always necessary for the patient to get up in order to get these phenomena occurring. A mere change of posture in bed may be sometimes sufficient. Dilatation of the stomach is, in M. Chauvet's estimation, an important factor in the causation of morning diarrhœa, for it not only allows of the food to accumulate in the viscus so that it can be poured in one large wave into the intestine, but it permits chemical changes of a fermentative or putrefactive nature to occur in it which may render it more irritating, and thus increase its likeness to a purgative purposely administered.

I can confirm his statement that dilatation of the stomach exists in these cases, inasmuch as I have found dilatation of the stomach present in some cases of morning diarrhœa, but it is by no means invariably so, and I do not think that it can be looked upon as the sole, or even the chief, factor in the causation of this complaint. In my own opinion, morning diarrhœa is usually dependent upon an irritable condition of the sigmoid flexure or even of the rectum. Sometimes I think there may be only chronic inflammation, or perhaps I ought rather to say chronic congestion, while at other times there may be actual ulceration. In the great majority of cases I find that there is tenderness on pressure over the sigmoid flexure. Sometimes one feels this hard and contracted like a rope, or even like a thick string under the finger on palpation. In order to understand the part which an irritable sigmoid flexure plays in the causation of diarrhœa, it is almost necessary that we should take a glance at its normal function.

In most healthy individuals the bowels are open only once a day, although food is taken several times in the twenty-four hours. The average sojourn of this food in the stomach we may take to be about three or four hours. In three hours more the contents

of the stomach will be passed down through the small intestine into the large one, and are still fluid as they enter it through the ileo-cæcal valve. It is in the large intestine that absorption mostly occurs, and that the fæcal masses become solid and moulded. The presence of its contents in the bowel acts as a stimulus to peristaltic movement, and it is probable that just as dilatation of the rectum causes expulsive efforts in it, so distention of any part of the bowel tends to increase the activity of its movements. In the case of the small intestine, the quickness with which its contents are propelled along the interior of the bowel varies very greatly, and Nothnagel observed that sometimes only half a minute, and at other times fifteen minutes, would be required for the intestinal contents to traverse the same length of bowel. Similar variations may also occur in the rapidity of the peristaltic movements of the large intestine. It is evident that if a quantity of fluid contents is propelled quickly down through the small intestine the cæcum will be rapidly dilated, and thus its peristalsis may be increased, and its contents passed on with much greater rapidity than usual. But this is not necessarily the case, and even with rapid action of the small intestine the large bowel may remain inactive, and then no diarrhœa will occur. Even if fluid matters should be propelled from the cæcum and transverse into the descending colon, there will still be no action of the bowels unless the sigmoid flexure participates in the peristaltic movement. Its shape, like the letter S, is admirably adapted to make it act as a trap to prevent any untimely descent of the contents of the colon into the rectum, and if it remains quiet, the intestinal contents will be retained until time for absorption has been given, even although the remainder of the intestine be in active movement. Should the sigmoid flexure, however, be irritable, and more especially should it have an ulcer upon its mucous membrane, the contents of the transverse and descending colon, when poured upon it, will be apt to excite peristaltic movements, and thus cause ejection from time to time of these contents into the rectum. There they will excite expulsive efforts, and thus the motions may be both frequent and liquid.

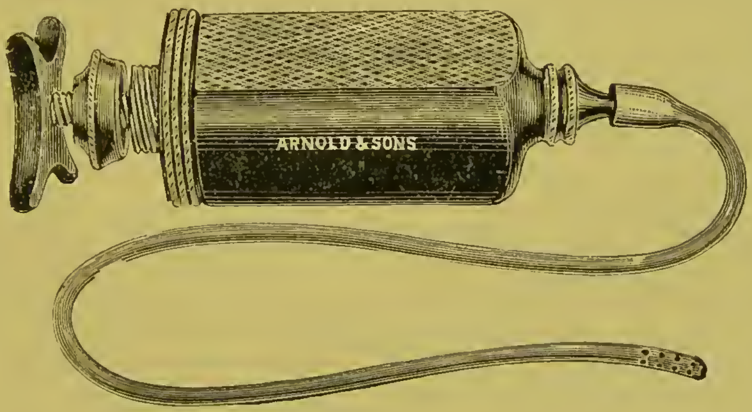
In the treatment of morning diarrhœa it is advisable to attend not to one factor only, but to all the factors that may contribute towards its causation. And, first of all, although I have denied the invariable occurrence of dilatation of the stomach in this form of diarrhœa, and thus questioned to a certain extent the correctness of the pathology given by M. Chauvet, I can quite corroborate the

utility of the dietetic treatment he recommends. This is very simple, and consists merely in entire abstinence from liquids after five, six, or seven o'clock at night, *i. e.* for twelve or fifteen hours before the attack would usually come on. If the patient finds this *régime* burdensome, he may perhaps be allowed to take a glass of wine with his dinner, but he should avoid all soups or other liquid at dinner, tea or coffee after it, and especially any aerated water either with or without spirits during the evening. By observing this dietetic rule, there will be little liquid to pass down into the large intestine when the patient rises in the morning, the peristaltic movements will thus be diminished, and the diarrhœa is either practically arrested entirely or very greatly diminished. If this limitation of drink is insufficient to check the diarrhœa, the quantity of fluid taken during the earlier part of the day should be restricted, so as to lessen the amount of water in the body generally, and thus increase the rapidity of its absorption. But in addition to this it is useful to lessen the irritability of the intestine generally by such remedies as bismuth and soda, combined with carminatives and aromatics, like spirit of chloroform and cinnamon water, both of which have no mean antiseptic powers.

In obstinate cases the most useful remedy is massage. We have all seen the effect of increased circulation in promoting healing in the case of callous ulcers of the leg. There the ulcer remains unhealed from day to day, week to week, and year to year, but if a blister be applied so as to increase the rapidity of circulation through the tissues, the ulcer takes on a healthy action and begins to heal forthwith. We cannot blister the interior of the intestines, but we can induce a healthy action in them by means of those kneading and rubbing movements which go under the name of massage.

In the case of the patient which I described at the beginning of this paper, the effect of a local application of ointment in causing healing of the rectal ulceration might be observed by ocular inspection. In order to apply ointments to the upper part of the rectum and sigmoid flexure I have had an instrument constructed by Messrs. Arnold. It is simply a modification of Allingham's ointment introducer. It is, to begin with, very much larger, and to the point is affixed a long red rubber tube which may be passed, if desired, from eight to sixteen inches or more into the bowel. By turning the screw with which the instrument is furnished, and at the same time withdrawing the tube, the ointment can be

applied to the bowel for a considerable distance. The case for which I had this instrument constructed was that of a young man, aged 19, who had been suffering from diarrhœa for nine months. He was so reduced by it that when I first saw him I thought he was in the last stage of consumption. His face was exceedingly thin; there was a bright, hectic-looking spot upon his cheeks, and his body was much emaciated. The bowels were open five or six times a day, and on examination the mucous membrane of the sigmoid flexure seemed to be partially prolapsed into the rectum, and there was also ulceration of the mucous membrane of the rectum for some distance up. I asked my colleague, Mr. Harrison Cripps, to see him, and he advised astringent injections to be used for some time. He had had diets of all kinds excepting meat diet, and so I put him upon that, allowing him fish and chicken as



much as ever he liked, along with toast. I also kept him in bed, and had him daily massaged. Under this treatment he slowly improved, laid on flesh, and the bowels became nearly regular. Even at the end of several months he had still a tendency to diarrhœa, but I then had the ointment-introducer made, and by the local application of bismuth, the bowel appeared to regain its normal condition. In other cases, however, I am bound to say that the massage and careful feeding has succeeded without the use of any ointment.

But it is not in morning diarrhœa alone that massage is of such value. It is of the greatest possible use in the treatment of that form of diarrhœa which is variously known under the name of hill diarrhœa, Ceylon sore mouth, and sprue, and to which the name psilosis has been given by my friend Dr. Thin. In regard to the

pathology of this disease, or these diseases, much remains to be done, and I do not think that we can yet assume that they are altogether identical. The usual symptoms are that the motions are always rather pale or clay-coloured and frothy. The stools may be normal in number for some days together, and then there is an attack of diarrhœa, during which the whole intestinal canal seems to be in a condition of irritation, the tongue, mouth, and œsophagus being all very tender, and shallow ulcers may be seen on the tongue and on the inside of the mouth. The best treatment and, indeed, almost the only treatment that is likely to cure such cases, is the exclusive milk diet, first introduced, I believe, by my friend Sir Joseph Fayrer. The effect of this treatment is in such cases simply marvellous. Some years ago I saw a patient who had been suffering for nearly ten years from this disease. He had tried all sorts of treatment, and when I saw him had just come back from a visit to Carlsbad, where he got harm rather than good. I put him upon a pure milk diet, and in his own language it acted like a charm, and in less than a fortnight he was free from his malady. But in some cases the milk cannot be borne, the patient takes an utter dislike to it, and cannot be induced to take it. In such cases it may be necessary to use a diet of pounded meat, pounded fowl, and pounded fish, without vegetables or bread; but just as in Weir Mitchell's cases of forced feeding in neurasthenia, massage comes in to help, and the increased appetite which follows the use of regular massage may enable the patient to take milk. But more than that, massage to the abdomen, which must, however, be very carefully used, tends to increase the absorptive power of the intestines, and thus to remove one of the conditions which keeps up the diarrhœa. In some cases it is advisable to let the patient go to bed while he is on milk diet, but in one which was under the care of Dr. Thin, the patient went about his duties on an exclusively milk diet for three months, and at the end of that time was obliged to lessen the quantity of milk he was taking, because he was growing too stout. In regard to the quantity of milk necessary to keep up a patient's strength, there exist, no doubt, great differences in different individuals. I had, however, a very useful experience while out at Hyderabad during the work of the Chloroform Commission, as I was attacked with dysentery, and for nearly a fortnight could take no solid food whatever. Even bread soaked in warm milk, and so soft that one would have said it could not possibly do any harm, brought on such pain that I was obliged

to give it up. During the whole fortnight, the daily quantity of milk that I could take was three tumblers full, each tumbler holding about nine ounces. On this quantity I was able to continue my work, though towards the end of the time I certainly became very weak and was obliged to go away for a change. The experience was to me very useful, in so far that it showed me that the quantity of milk required to maintain the body is less than I should have imagined. One must, no doubt, take into consideration very carefully the size of the individual, and my stature is considerably below the average, being 5 ft. 4 in., and my weight 10 st. 9 lbs.; nevertheless, I think we are sometimes over anxious to push the quantity of milk daily taken by patients too far, and perhaps overload the stomach to their disadvantage. Yet I must not quit this subject without mentioning that a most important factor in regard to the diet is the temperature of the body, because a single degree of rise in temperature means a great increase in the waste of the tissues, and a quantity which might be sufficient to maintain a body at ordinary temperature might be quite insufficient to supply the waste in a fever patient. The subject of typhoid fever is far too great to take up here, but it is, I think, especially in relation to this disease that the effect of temperature upon the amount of milk required is to be borne in mind. In sprue there is usually no rise in temperature, and the remarks that I have made upon not pushing the milk too far refer more especially to its treatment.

Another form of diarrhœa to which I should like to direct your attention is that in which the desire to go to the closet comes on either while taking food or immediately afterwards. I think that there can be little doubt that this is due to a condition of increased excitability of the nervous system of the intestine, so that the impulse given to the stomach causes increased peristalsis throughout the whole of the intestinal canal. In one case under my observation this condition was accompanied by pain in the hypogastrium immediately after eating, and to the hypogastric pain a motion quickly succeeded. The patient observed, however, that both these conditions only came on when he took aerated water along with his food, and when he substituted plain water, neither pain nor the motion was produced. From this case one might infer that distention of the stomach was the exciting cause of the peristalsis in the bowel. According to my experience, this condition is not very common among adults, but is very common

among children, and the treatment which I have found very satisfactory, both in children and adults, is that recommended by Dr. Sidney Ringer, namely, one or perhaps two drops of liquor arsenicalis in a little water before the meal. In place of arsenic one may give another drug which belongs to the same chemical group as arsenic, but is very much less powerful in its action, namely, bismuth, and half a drachm or a drachm of the liquor bismuthi et ammonii citratis appears to me to have an action very much resembling that of one or two drops of liquor arsenicalis in these cases.

The last form of diarrhœa which I will mention is that due to malignant disease of the lower bowel. One case of this sort which I saw several years ago impressed itself very strongly upon my memory, both on account of the extraordinarily fine personal qualities of the patient and the long continuance of the disease. When I saw him he was a man of about 67, had been in the navy all his life, and had spent most of it in cruising to all parts of the world. He had been, nevertheless, remarkably healthy, and had never suffered from malarial fever to his knowledge. For no less than eight years before I saw him he had suffered from diarrhœa, coming on several times a day, generally in the forenoon, and not interfering with his work at his bureau. When I saw him, at the beginning of August 1885, he was pale and anæmic. The bowels were open about three times a day; the motions were of a curious chocolate colour, with small lumps looking like boiled rice or tapioca mixed with them. Each motion was followed by excessive depression and weakness. As he had been put upon a very limited diet without advantage, I increased his diet, being, however, careful to avoid things that would cause irritation, and for a month or six weeks he seemed to improve rapidly, so much so that Dr. Langston (with whom I saw him) and I thought that he might go to the country. Before he could be moved, however, a change occurred, and he sank rapidly. On *post-mortem* examination the lower third of the sigmoid flexure was found to be affected with malignant disease surrounding it like a ring, about two inches in breadth. The rectum was perfectly free.

When malignant disease is situated lower down in the rectum, the stools are likely to be much more frequent and scanty, and one thing that is very likely to mislead one is the appearance of the patients, who often may look the picture of health.

In all cases of chronic diarrhœa it is advisable never to omit

an examination of the rectum, because thereby disease may be discovered in time to allow of its removal by operation, whereas, if its existence remains undetected, it may progress to such an extent that no operation for its removal is possible, and all that can be hoped for is to palliate the patient's sufferings by means of colotomy.

In cases either of malignant disease, of simple ulceration, or of stricture of the bowel, I have found the following diet table useful. It serves also for cases of gastric ulcer.

Directions for Diet.

Swallow nothing that has not been either passed through a hair-sieve, or has been so thoroughly masticated in the mouth that it is of the consistence of cream, and would readily pass completely through a hair-sieve without leaving any remainder.

Avoid—

All Skins—Bones—Strings, and Stones.

Where these things cannot be removed the article of diet must be rejected.

Skins of Fruit, *e. g.* of grapes, peaches, apricots, gooseberries, marmalade. Reject currants, raisins, or anything containing them, *e. g.* cake.

Skins of Vegetables, *e. g.* tomatoes, potatoes. Reject peas, beans.

Skins of Fish of all kinds. Reject sardines, whitebait.

Skins of Fowl.—Fowl, game, larks, quails.

Bones of Fish, *e. g.* sardines, herrings, trout. Reject whitebait.

Strings in Fruit.—Oranges, peaches, apples, pears, bananas, tamarinds, mangoes.

Strings in Vegetables, *e. g.* asparagus, cabbage, cauliflower. Reject carrots and turnips, unless mashed and passed through a sieve.

Strings in Meat.—Stringy fibres of beef, sinews in larks, quails, fowl, and game.

Stones or Seeds of Vegetables, *e. g.* tomatoes. Avoid peas and beans unless carefully chewed.

Stones or Seeds of all kinds of Fruit.—Of grapes or raisins. Reject nuts, almonds, strawberries, raspberries, currants.

Strawberries, raspberries, or currants may be pulped either alone or with sugar or cream, and may be passed through a fine sieve. The juice thus obtained may be taken either alone or with farinaceous food.

May Have—

Milk, with soda-water or lime-water, or even alone, if sipped and eaten with rusk or biscuit, and well mixed in the mouth.

Bread, if stale; new bread to be avoided. All bread that breaks down under the finger and thumb, into crumbs, is old enough. Bread that under the finger makes a stiff dough must be avoided.

Rusk, or biscuit, or cracker, or bread-and-butter (not crust), provided it be well chewed in the mouth, so that it is of the consistence of cream before it is swallowed. Eggs in any form except hard-boiled or fried.

GENERALLY the patient may have anything (fruit, vegetables, meat, fish, or game) that has been passed through a sieve.

All kinds of corn-flour, tapioca, sago, rice, if well boiled and well chewed.

Macaroni, vermicelli, spaghetti, sassagna, Italian paste. (These may be

boiled in stock, which may be made with vegetables, if the vegetables are strained first. Essence of celery in quarter to one drop as flavouring.)

Cocoa, freely.

Tea (China), infused for short time.

Coffee, if it cause no distress.

Butter, in moderation.

Cream cheese, in small quantity, and well mixed with bread in the mouth, or grated parmesan, but must *not* have any other kind of cheese. (*No Stilton cheese.*)

Gravy from any kind of meat.

Savoury jellies (if there are no solids in them).

Sponge biscuits.

Madeira cake (*plain, no currants, no peel*).

Grated meat, tongue, &c.

Toast, if it be well masticated.

(*No hot buttered toast.*)

Yorkshire (batter) pudding, with gravy, if well masticated.

Bread or toast in soups.

Honey or golden syrup.

The syrup of jam or marmalade with the seeds or skins strained out carefully; fruit jellies, *e. g.* apple jelly, quince jelly, guava jelly, with bread or bread-and-butter, or with any kind of corn-flour or arrowroot, or macaroni, or any kind of farinaceous food allowed.

ABDOMINAL PAIN.

Clinical Lecture delivered at St. Bartholomew's Hospital.

(From *International Clinics*, 8th Ser., vol. iii. p. 111, London, T. Lewin and Co., 1899. Reprinted by permission.)

Gentlemen,—The subject to which I wish to draw your attention to-day is that of abdominal pain. I do not intend to include all varieties of such pain, but shall confine myself to a few. I do not intend to take up the subject as connected with acute inflammatory disease, and shall deal with some other forms that are less known and often misunderstood.

I have been led to take up this subject by the fact that we have several cases presenting abdominal pain of various kinds in the wards at present. We have one more especially who has been transferred to the care of the surgeons, and who was operated upon the other day. In "Elizabeth" Ward there is a patient with calculus in the gall duct, and in "Rahère" Ward one with pain in the back, which is suspected to be due to renal calculus.

Apart from acute inflammation, pains in the abdomen are generally due to one or two causes—(1) Active contraction or cramp of involuntary muscular fibre; (2) excessive passive dilatation of involuntary muscular fibre.

Most of the organs in the abdomen either consist of, or are largely composed of, involuntary muscular fibre. The first one that attracts our attention is the colon. Spasmodic contraction of the colon gives rise to acute and severe pain, to which the name of colic has been given. This may be due in some instances to cramp-like contraction of the colon, the pain in the involuntary muscular fibre being severe and acute, and just like that which occurs in the calves of the legs after a very long day's walking. Not infrequently it would appear that the pain in the colon is not due to contraction of the colon throughout its whole length, but is rather due to partial contraction at one place and dilatation at another. The name of colic has been extended from the disease

which first gave it the name, to other forms of pain which are not connected with the colon at all. We speak now of biliary colic and of renal colic, and by these terms we understand the pain which is caused by the passage of a calculus through the biliary duct or through the ureter. In these two cases the pain is probably due to the distension of the duct by the calculus which is passing through it, but, of course, as we are unable to examine the duct at the time, we cannot tell how far the pain is due to mere passive distension, and how far it may really be due to a cramp-like contraction of the involuntary muscular fibres in the duct, caused by the stimulus of the calculus within it. It is possible, therefore, that there may be two causes of pain in renal and biliary colic, namely—(1) Passive distension of the duct by the calculus; (2) active contraction, or spasm of the duct, due to reflex irritation from the calculus.

There is another pain which may seem very far removed from colic either of the colon, of the ureter, or of the bile duct, but which I believe is often closely associated in its pathological nature with it—that is the pain of migraine. I do not know whether any of you have been unfortunate enough to suffer from his disease, but you have probably read up the literature, and have found that the statements given by various writers differ very much regarding the condition of the vessels in migraine According to some authors, the vessels are widely dilated and pulsating forcibly. According to others, the vessels of the head are firmly contracted, spasmodically contracted, so that the arteries feel like a piece of whipcord. Both these statements are quite correct, but each of them is only partially true. I have had the misfortune to suffer from migraine to a great extent, and I have found that when the headache is present, the carotid is widely dilated and pulsating furiously. It feels so much dilated, indeed, that it appears under the finger to be of the thickness of the thumb, instead of the ordinary thickness of the artery. When followed onwards in its course, however, I have sometimes found that as it crosses the temple, the artery is still widely dilated, and part of it pulsating wildly; but on other occasions, instead of this temporal artery being dilated, it is firmly contracted, and feels like a bit of whipcord under the finger; so that if your attention were directed only to the temporal artery, you would say that sometimes it was dilated, and sometimes contracted, yet it is impossible to notice any difference between the pain in these two

cases. But if you examine the carotid artery you always find it widely dilated, and if you pass onwards to the temporal artery, to the little branch that turns upwards along the forehead, you will always find that one contracted so firmly that it is sometimes like a bit of piano-wire under the finger—harder than whipcord. The condition in the arteries, therefore, that we find in cases of headache is proximal dilatation and peripheral contraction, and the pain is apparently due to the fact that the peripheral part of the artery is so firmly contracted. If you check the tension of the peripheral part of the artery by pressing the carotid, you will at once relieve the pain, but unfortunately this runs so close to the vagus nerve that you cannot keep up pressure upon it for any length of time. After a short period of oppression, the irritation to the vagus becomes so great that the whole chest seems to be contracted. There seems to be a tremendous weight upon it. It produces almost a feeling as if a giant's hand were pressing it, and it is necessary to remove the finger from the carotid. At once the pain comes back with a shoot, and continues to increase with every throb of the artery, being diminished in the intervals between the pulses.

Now, this condition which we notice so clearly in the temporal artery and its branches as a cause of pain, and of acute pain, prevails, I believe, in many parts of the body where we cannot see it. That we have frequently in the interior of the abdomen, a similar condition to what we get in the head. We find then one class of pain, which, as I have said, is very little recognised—pain which comes on in the abdomen, is spasmodic in its nature, and occurs for a limited period. This pain is frequently not associated with any disturbance of the movements of the bowels. The bowels may be perfectly regular, digestion may be in every respect good, the health of the individual may appear to be perfect, and yet he suffers frequently from this abdominal pain. In some cases it comes on in the middle of the night and will arouse the patient, who is kept awake by it for several hours, and then he may fall asleep for an hour or two and awake perfectly free. It is a curious fact that sometimes patients who suffer from such pain are perfectly well when they are standing up, but begin to suffer only when lying down; others again are perfectly well when lying down, and only suffer when they are standing up.

It is now about fourteen years ago since my attention was first directed to this class of abdominal pain, by the late Dr. Matthews

Duncan sending me a patient who had seen a great many other men, and had been treated by them without any advantage. I am bound to say that I treated him also without doing him any good whatever. I did not at that time understand the nature of the pain, but I believe now that it is to a great extent due to some irregular contraction, either of the vessels which supply the intestines, or of the intestinal muscular fibres themselves, I cannot at present say to which of these structures the pain is due. The class of case in which you meet this pain is generally that with a rheumatic or gouty tendency. The patient whom I saw first of all was very distinctly gouty, his urine contained large quantities of uric acid crystals, and many crystals of oxalate of lime, but these are not always to be found in the urine of patients suffering from such an affection. In many of these people diet seems to have very little effect. The bowels continue regular, the digestion good, and they seem to be able to take anything they like as far as regards indigestion; more than that, diet does not seem to any great extent, at least, to influence the pain. There are certain causes that are apt to bring it on, perhaps more acutely than it would otherwise be, such as fruits which contain a number of seeds, like figs and strawberries, in which the small seeds are completely indigestible. But with this exception, I do not think articles of diet have much to do with it. I think that wine occasionally tends to bring it on, but its action is so irregular in these cases that I cannot even say that wine has much to do with it. During the attack there is sometimes a little distension of the intestine with flatus, and apparently at one part or another of the bowel there is flatus present and cessation of contraction. There seems to be no reason for this distension in the condition of the bowel itself, but probably it is a nervous dilatation of the same nature as that which occurs to the carotid artery in the case of sick headache. The pain may be relieved generally by the use of some stimulant or carminative. For example, a small quantity of neat brandy with a little peppermint in it will often cause the wind to move, and will relieve pain almost immediately. Other carminatives, such as the essence of ginger in hot water, have a somewhat similar effect, and frequently you may find that a mixture of peppermint, ginger, and sal volatile will relieve it more quickly than most other remedies. Friction over the abdomen will tend to ease it, and when once you begin to hear a gurgling in the intestine, you know the pain will very soon go, because as soon as the wind

in the intestines begins to move, this pain seems to disappear. Sometimes friction between the shoulders, and oddly enough, friction over the trapezius muscles, or over the deltoid, will tend to make the wind pass along the bowel and will relieve the pain.

Now, we do not know why this should be, but, in all probability, it is due to some reflex action through the vagus. The part of the body supplied by the spinal accessory seems to have a peculiar relationship to the stomach and bowels, and if you rub the skin over this part you will often notice reflex action in the stomach and bowels, tending to cause expulsion of wind, and thereby ease to the patient.

We know very little about the pathology of these cases. I was talking over them with Dreschfeld once, and he told me that he knew of one case in which a post-mortem examination had been made, and that atheroma of the vessels supplying the intestine had been found, but so far as I know that is the only information we have of the exact pathology of the cases. As regards the general treatment of them, we treat them very much as we would treat a sick headache. Try to relieve the gouty or rheumatic tendency of the patient. You will find that in such cases as I have mentioned the continuous use of small doses of salicylate of soda, more especially combined with bromide of potassium, will be of great service. Many people get up almost every morning with a headache, and in the same way many people suffer from these pains in the abdomen every morning. The headache passes off in some persons just after breakfast, and these pains disappear in many people just after they get up.

Every now and again we meet with another class of pain in the abdomen which is analogous to the severe headaches which some people suffer from every fortnight or three weeks. Some years ago a doctor came to consult me about a curious form of pain in the abdomen from which he suffered, and which was so severe that he had almost given up his practice. It was in April 1893 that I saw him. He was then æt. 39, and for seventeen years he had suffered from pain in the abdomen, with prostration and depression, every eleven days. For two or three days before the pain came on he suffered from flatulence, and the attack began on waking in the morning with uneasiness and slight pain in the abdomen, which gradually increased. If he were to take breakfast he got a sharp pain at once. During the day there was a rumbling and gurgling, and a feeling, he said, as if his pylorus was shut up.

The pain remained constant during the day, but was liable to occasional exacerbations; and if he were shaken at all it became very severe, so that on these days he could hardly drive about in his carriage to see his patients. At the time these pains commenced, he was going up for his second professional examination as a student, and had been working very hard. He then became liable to indigestion, had bitter eructations, was severely ill for a fortnight, and was slightly jaundiced. From that time onward he continued to suffer in the way I have mentioned. The pain through the attack was in the pit of the stomach, and it passed right through to the back; all the other organs were perfectly normal. I should say that he had no headache, but before the attacks came on there was a slight heaviness over the forehead. After examining him carefully, I said to him, "In all probability, you will laugh at my diagnosis. I think you have got headache in your stomach." Instead of laughing, as I expected, he looked startled, and said, "That is very odd. I came up from Edinburgh to consult two or three men, and you are the third man I have seen, and you have all given the same diagnosis." I advised him to take some bromide of potassium and some salicylate of soda, and under this treatment he very greatly improved indeed, so that he is now continuing his practice successfully.

I have met with a very considerable number of cases in which I have diagnosed headache in the stomach, and the other day I found to my astonishment that the mother of a patient had come to a similar diagnosis. She brought her daughter to me, and told me that she suffered from pain in the stomach, but that she also suffered from headache; and sometimes, as the mother said, the pain would go away from the head and come into the stomach, and *vice versâ*. In fact, the mother said, "she seemed as if she had got a headache in her stomach." In such cases, I believe that the condition in the vessels of the intestine is likely to be much the same as it is in the head—peripheral dilatation, with proximal contraction—and that the pain occurs in the stomach in the same way as in the head. But then the question comes to be —Why do you have it in the stomach instead of in the head? Now, we know that sick headaches are nearly always determined by some local source of irritation; that in nine cases out of ten people who suffer from them have some defect of vision, the two eyes being of unequal focus, or there is some astigmatism, myopia, or presbyopia. In one case of a student here, the head-

ache depended upon the want of convergence of the two eyes Occasionally, too, we find that the headaches may depend upon irritation not in the eyes, but in the teeth, or in the nose. If you can remove the local irritation, you will very often relieve the headache, although you leave the general condition of the patient untouched. In the same way, I believe that in a number of these cases of pain in the intestines, there is some source of local irritation, and I believe this to be, in many of them, some old adhesion. Old adhesions due to peritonitis in former days, I believe exist a good deal more frequently than one has any idea of. The operation which was done by Mr. D'Arcy Power, a few days ago, upon Annie K., showed this fact. The history of the case was that she had been perfectly well until nine weeks ago, when she felt a sudden pain on moving, which was first in the left lumbar region and afterwards in the right hip. Now, that is not the history that would lead one to expect a number of old adhesions by binding down the sigmoid flexure and colon of the patient, and yet on opening the abdomen a number of old adhesions were found. The pains I have described are sometimes very persistent, and will last in spite of all sorts of treatment. The longest duration that I have known was in a patient who had them for forty-five years. He was liable to pain every morning and whenever he lay upon his right side; if his bladder became full the pain came on at once, but was relieved by evacuating the bladder. In his case, it seemed to me that he had some old adhesions causing the bladder to become adherent to the intestine. In going into the history of the case, he informed me that, when quite a young man, he had been out in a boat one day with a number of ladies, and he had great desire to pass water. He did not like to do so, and so he held on until he was able to return to land; but from that day onwards he had had this pain. I believe that he had simply stretched his bladder so much that he had a little inflammation round it, and had got adhesion of the bladder to the intestine. In his case I prescribed also bromide of potash and salicylate of soda, treating it just as I would a case of headache, but I have not seen him for years, so do not know whether he was relieved or not.

I may just say a word about the pains in those other patients whom we have in the wards. In the case of the one in "Elizabeth" Ward, who was brought in actually suffering from the pain of hepatic calculus, we found that the pains had not quite

the ordinary distribution that we find in the rest of renal calculi. In such cases we generally find the pain radiating from the region of the gall bladder onwards and upwards, running towards the left and running upwards. We may find it running downwards and obliquely towards the umbilicus, but it rarely gets below this. The patient in "Elizabeth" Ward complains that the pains radiate in the direction marked on the diagram, below the umbilicus; that is quite unusual, so that we begin to ask ourselves whether it is a case of pure biliary calculus, or whether there may be something more at the back of it, possibly some malignant disease. The aspect of the patient is certainly not that of malignant disease. The history of the case and her aspect are both those of simple biliary calculus.

It is sometimes rather difficult to distinguish whether the pain felt upon the right side is due to a biliary calculus or to a calculus passing down the ureter—a renal calculus. Of course in the patient in "Elizabeth" Ward, the diagnosis is facilitated by the fact that she is deeply jaundiced, so that we think there of a biliary and not of a renal calculus. But in some cases of biliary calculus the patient is not jaundiced at all, and the reason of it is simply this, that when a stone is passing from the gall bladder into the duct, it may be just of sufficient size to distend the vesical duct, and to cause pain as it passes down from the gall bladder; and yet although it is large enough to do this, it is not large enough to block the common bile duct. And so the pain which is due to the distension of the biliary duct by passage of the gall stone, may cease abruptly whenever the gall stone gets into the common bile duct. You may find intense pain in the right side in a patient which leads you to think that it is due either to distension of the gall duct or of the ureter by calculus, and seeing no jaundice, you are in a little difficulty to decide which it is.

Now, you may say at first that the diagnosis ought to be perfectly easy, because if a stone is passing down from the right kidney, there should be albumen in the urine, but that does not always help you. Because, supposing you have the kidney with a stone in it, the stone may fall into the ureter, so that you may have absolutely normal urine, because the ureter is completely blocked up. Of course, as a rule, the diagnosis clears itself up in a day or two, because as the substance that is causing the blockage passes down, you find either blood or albumen in the urine. But for a couple of days, at least, you may have perfectly

normal urine, which is derived from the other kidney, and yet the ureter on one side is completely blocked. The point that we generally attend to in trying to diagnose between these two cases, is the conduction of the pain. In the case of the renal calculus, the pain generally passes down, and very often is felt pretty acutely in the testicle corresponding to the kidney in which the calculus is found.

In regard to the treatment of pain in the abdomen, I have mentioned to you that those chronic pains which are like those of headache, and which come on in gouty and rheumatic patients, are best treated by the use of salicylate of soda and bromide of potassium. In some cases where the pains are due to irritability of the intestine, you may relieve them by codeine, which has the same sedative effect upon the intestine that morphine has, and it does not tend to cause the same amount of constipation. The pain of biliary and renal calculus is somewhat relieved by warm baths and warm fomentations, but, as a rule, when the pain is too acute for that, you have to try something stronger. I have sometimes found great relief from the administration of the compound spirit of ether, and a mixture I not infrequently use is—

℞.
Sp. Æther. Co. minima, x. vel. xx. ;
Sp. Æther. nitros. ʒ ss. vel. i. ;
Sp. Chloroform, minima, x. ;
Sp. Ammon. aromat. minima, xv. ;
Aq. menth. pip., ad. ℥ i.
Misce. ; fiat haustus pro re nata sumendus.

And to this I very often add a preparation which is not in the Pharmacopœia, namely Nepenthe, in doses of 10 minims. This mixture very frequently gives considerable relief, but if the pain is very severe you may give it and get very little good out of it, because then I do not think absorption goes on to any great extent in the stomach, and practically, in these very severe cases, the only thing one can do is to give subcutaneous injections of morphine. You may try a sixth, and if not sufficient, as very often it is not, you can give up to a third or even half a grain; but even after this, if you find the patient is not relieved, what are you to do then? Are you to go on giving morphine indefinitely? I think it is best not. We find sometimes that

patients do not seem to obtain relief, and the pain in some of those cases is simply awful. I have seen a very strong man, one of the strongest and healthiest I have ever seen, simply squirm like a worm that had been trodden on under the effect of a calculus passing down from his gall bladder. When morphine does not give relief, the next best thing is to give some chloroform, and the effect of this added to that of the morphine will very often be to obtain quiet. There are some cases where it is difficult to get the pain subdued at all, and I have used Junker's Inhaler, giving the man the ball of the inhaler in his hand. When the pain became excessive, he worked the ball, and as soon as he got a certain amount of chloroform vapour into his lungs the pain subsided. Then, as the effect of the chloroform has passed off, the pain began to increase again. I let him work the ball again, and in this way obtained a sort of self-regulating apparatus. The greater the pain the more the man worked the ball, and the more chloroform he inhaled, but as the pain subsided he ceased to work the ball, he consequently inhaled less chloroform, and so there was no risk of his getting an overdose. It would be impossible to go into all the causes of abdominal pain, because they are very numerous, and it would take many hours to go through them, but some of those mentioned are instructive.

ON THE USE OF CODEINE TO RELIEVE PAIN IN ABDOMINAL DISEASE.

Reprinted from the *British Medical Journal*, June 9, 1888.)

I HAD intended to bring the subject of this paper before the British Medical Association at its last meeting, but I was unfortunately prevented from attending, and delayed publication of this paper for several reasons, one of which was the desire to obtain a larger experience of the utility of the drug. The relief of pain may be classed next to the saving of life, and must perhaps sometimes be even put before it as the chief duty of the physician. As yet no drug has taken the place of opium as a general analgesic, though the use of crude opium is now frequently replaced by the subcutaneous injection of morphine, the most active of the alkaloids it contains. In abdominal pain many practitioners still have a preference for the use of opium, as compared with that of morphine, and this very preference is sufficient to make one ask whether it may not have some foundation in the presence of other active principles along with morphine in opium, and if so, to inquire which active principle it is that helps to allay pain.

Thanks to its recommendation by Dr. Pavy, codeine is largely used in the treatment of cases of diabetes, but at present its use is almost confined to this disease, and it is rarely employed for other purposes, excepting perhaps that of soothing cough or irritation in the throat.

Codeine was discovered by Robiquet in 1832, and two years afterwards its action was tested upon himself by Gregory,[1] who found that instead of causing sleep it rather caused excitement, and had also a slight laxative tendency. It was applied therapeutically by Barbier[2] in 1834, who noticed that it seemed to have a special action upon the sympathetic system, and found that it was of great use in lessening pain in persons presenting symptoms

[1] Gregory, *Journ. de Pharm.*, February 1834.

[2] Barbier, letter to Acad. de Méd., *Schmidt's Jahrb.*, vol. ii. p. 267.

of irritation in the solar plexus. Such symptoms are pain in the epigastrium, spreading to the sides and back, and associated with a feeling of burning, anxiety, depression, more or less tenderness of the epigastrium, with sighing, lack of energy and tendency to faint. Occasionally the pain may cause symptoms of collapse, palpitation, and vomiting. In such cases Barbier gave a grain of codeine in a tablespoonful of syrup, and repeated it if necessary in one or two hours with the best results. From his observations he came to the conclusion that codeine acts chiefly upon the sympathetic nervous system, and especially upon that part of it which is in the region of the stomach; that it is a most useful remedy in abdominal neuroses depending upon disordered condition of the nervous plexus in the abdomen, and especially those in the gastric region; that it does not disorder the digestion, and rather aids than interferes with the action of the bowels. He found also that it produced sleep with tolerable certainty, and that this sleep was never followed by heaviness in the head or stupidity, but, on the contrary, persons who had taken it felt happy, and were disposed to be cheerful on awaking. About twenty years later, in 1856, Robiquet's[1] son undertook some observations on the action of the drug which his father had discovered. The results he obtained, however, did not quite accord with those of Gregory or of Barbier, and it is possible that the discrepancies may have been due to more or less impurity in the drug employed. In large doses he found that it caused an unrefreshing sleep, followed by a period of confusion of thought; occasionally nausea and vomiting were produced. In small doses he found it of great service in hypochondriasis, relieving nervousness, irritability, and all the discomforts from which patients affected with this disorder are apt to suffer.

Shortly afterwards Berthé[2] made a much more full and complete investigation of the physiological action of the alkaloid. Amongst other things he confirmed Barbier's observation that it had a specific action upon the sympathetic, and found that it lessened the irritability of the intestine to such an extent that a dog which had received 15 grains of arsenic along with 7½ grains of codeine exhibited neither vomiting nor purging, nor any other symptom excepting drowsiness, while another dog which had received a similar dose of arsenic without the codeine began to suffer in the course of an hour from severe pain, vomiting, and bloody diarrhœa, and indeed pre-

[1] Robiquet, *Gaz. des Hôp.*, 1856, xxxix. 517.

[2] Berthé, *Moniteur des Hôp.*, 1856, iv. 596, 601, 602, 1052.

sented well-marked symptoms of arsenical poisoning, although it ultimately recovered. These experiments suggested the idea to me that codeine was likely to be of service in abdominal pain, and I proceeded to try it with very satisfactory results. The class of cases in which I have used it is, I think, somewhat different from those in which it has previously been recommended, because while Barbier, Aran and others have chiefly employed it in gastralgia and painful disorders of the stomach, I have used it chiefly in pain affecting the intestine and lower part of the abdomen. The kinds of cases in which I have used it have been very varied. As examples I may shortly describe one or two. In one case which I saw with Dr. Eccles, there was high temperature, intense pain in the right iliac fossa, with considerable swelling, so that there could be little doubt that there was inflammation around the cæcum, although examination after the acute symptoms had subsided showed that there was also pelvic cellulitis. In this case one grain of codeine, given in the form of a pill, relieved the pain at once, and repetition of the dose whenever the pain began to return prevented its becoming at all severe.

In another case, seen with Dr. Philpot, of Croydon, a lady, aged 50, had pneumonia of the right base, a greatly dilated heart with very irregular action, pulse so rapid and weak that it could hardly be counted, and pain over the epigastrium and spreading out from it. She was slightly jaundiced, and a tumour was felt in the right lateral abdominal region, which descended with respiration, but was partly covered by intestine, and could be moved from side to side, so that it seemed to be renal rather than hepatic. As no *post-mortem* examination was obtained the exact diagnosis could not be established, but the administration of codeine in half-grain doses relieved the pain, as Dr. Philpot said, "as if by magic."

In another case, seen with Dr. Pardington at Tunbridge Wells, there was pain in the abdomen depending upon a mass of impacted fæces in the transverse colon. In this case codeine seemed to be especially indicated, as one wished to relieve the pain without interfering with the action of the bowels. In grain doses codeine relieved the pain, and the use of copious enemata, aided by washing out the stomach, cleared away the impacted mass which had given rise to the disturbance. I have tried codeine in cases of long-continued abdominal pain for which no definite cause could be assigned, as no tumour could be felt, and the functional disturbance did not seem sufficient to warrant a diagnosis of malig-

nant disease. I have tried it in cancer of the liver and pancreas with success in relieving pain, and also in numerous cases where the age of the patient, the presence of diarrhœa, tenderness on pressure, and visible peristaltic movements, and thickening of the gut, easily perceptible on palpation, led to the diagnosis of malignant disease in the intestine, although inability to obtain a *post-mortem* examination prevented the confirmation of the diagnosis. In such cases I generally begin with half a grain, in the form of a pill made up with extract of gentian, three times a day; and if this is insufficient to control the pain I increase the dose to a grain, and give it as frequently as seems necessary. As a rule, I find that it does not produce drowsiness, nor has it interfered with the digestive functions.

To sum up, the results I have obtained from the administration of codeine have satisfied me that it has a powerful action in allaying abdominal pain, and it can be pushed to a much greater extent than morphine without causing drowsiness or interfering with the respiration or with the action of the bowels. It is, therefore, specially indicated in such a case as Dr. Philpot's, which I have already mentioned, where the dilated heart and consolidated lung tended to make one afraid of morphine. Codeine is also specially indicated in a case like Dr. Pardington's, where one wished to relieve the pain without interfering with the action of the bowels. On the other hand, in cases where there has been much diarrhœa, as in some cases of malignant disease of the colon or rectum, the absence of any tendency to lessen peristaltic movement is rather a disadvantage to codeine as compared with morphine or opium.

I have found that in cases of long-continued enteralgia without organic disease, it has continued to relieve pain for months together, without the dose being increased beyond one grain three times a day, and I found the same to be the case where the presence of a tumour, in addition to other symptoms, had led to the diagnoses of malignant disease.

It is interesting to follow the vicissitudes of a drug, and to notice how its use extends or diminishes until at last it finds its right place and maintains it. Thus digitalis, while mentioned in the London Pharmacopœia of 1721, was excluded from that of 1746. It again appeared in 1788, and since then it has held its place.

Possibly codeine, after falling into almost complete disuse as an analgesic for many years, may again regain a more or less important place amongst the remedies which enable us to relieve pain.

CHOLERA NOSTRAS AND CHOLERA ASIATICA.

A Clinical Lecture delivered at St. Bartholomew's Hospital, on Friday, July 9, 1897.

(Reprinted from *The Hospital*, July 24, 1897, p. 289.)

TO-DAY I propose to draw your attention to cases of what is termed cholera nostras. There are two kinds of cholera which are usually distinguished from one another, namely, the Asiatic form and the European form or cholera nostras. The main difference between these two kinds is said to be the occurrence in Asiatic cholera of pure rice-water motions, untinged in the very least by bile. The motions look almost like rice-water; they are quite colourless, with only a slight whitish opacity and sometimes flakes of mucus present in them. In cholera nostras, on the other hand, the motions may be quite fluid, but they are generally more or less tinged with bile or with fæculent matter. As I shall have to mention, however, this clinical distinction does not always hold, and I know that it does not hold because I had an experience of cholera nostras in my own person some four months ago. I went to bed perfectly well. Between one and two o'clock I awoke and felt sick. I then was seized with violent vomiting, so violent that the whole of the contents of the stomach were brought up, and then followed mucus tinged with blood. Now you do not generally get mucus becoming tinged with blood unless the vomiting is very violent. While the vomiting was still continuing I was seized with a desire to go to the closet, and then the motions were somewhat of the same character as the vomiting, namely, exceedingly violent, coming away in violent gushes. The evacuations were perfectly fluid, and at first consisted of fluid fæcal matter, but the fæcal colour disappeared, and finally the motions were absolutely colourless. They were just like rice-water, and, in fact, were precisely similar to the motions that we find in Asiatic cholera; there were, however, no cramps.

There was comparatively little pain in the abdomen, and as soon as the vomiting and purging had ceased, I fell asleep and awoke after two or three hours' rest with no further symptom excepting excessive weakness. This, however, was not so great as to prevent me from going through my ordinary day's work. In my case, therefore, the accession of the symptoms was very sudden; they were very severe while they lasted, but they were local and not general. There were vomiting and purging with great violence, but there was no cramp, no abdominal pain, and there was not the excessive prostration that you usually find in cases either of cholera nostras or Asiatic cholera. I took no remedy, excepting that on the next morning I had a little bicarbonate of soda and bismuth, so as just to quiet a little nausea that still remained, and I had no further return of the symptoms. My case, therefore, shows that the one clinical symptom that may be looked upon as distinctive does not differentiate completely between Asiatic cholera and cholera nostras.

The great majority of cases of cholera nostras recover, but they do not always do so—at least, they do not if we accept as a distinction between cholera Asiatica and cholera nostras the fact that the motions contain bile. Some years ago there was an epidemic of cholera in London, not a very great one, but still there were a good many cases. At that time I was called to see a patient living at Kew. He was a gentleman with no definite occupation, and amused himself a good deal by boating upon the river. He had taken his wife up in a boat towards Oxford, and after they had gone part of the way he got out and towed the boat. In doing this he had to cross a field which was watered with liquid manure. The smell was exceedingly powerful and very disagreeable, and, as he expressed it, "it seemed to get about his heart." It made him faint and sick. He continued to tow for a while, then got into the boat again and went on a little further till he came to a public-house. He sent for some beer, thinking that this would quiet his stomach, but he became violently sick immediately, and continued suffering more or less for a day or two. He came back to Kew, and I then saw him. He was suffering from violent sickness and violent diarrhœa. His face was getting thin and shrunken, his colour was slightly bluish, the surface of his skin was cold, his pulse was very feeble, and he had marked cramp in the extremities, but the motions, although perfectly liquid, were always tinged slightly with bile. In spite of all I could do, however, the man's

strength gradually diminished, and he sunk and died. Although one might be inclined to say, from the occurrence of other cases of Asiatic cholera in London about the same time, that this was a case of Asiatic cholera, yet the clinical difference, the colourless stools which is usually recognised as being the typical symptom of Asiatic cholera, was absent in his case, whereas it was present in my own case, and yet I had no further severe attack. You see, therefore, that we cannot rely upon this clinical difference between the two kinds of cholera, and I do not know that there is any other difference upon which you can rely, because, as you see, cholera nostras may present all the symptoms of Asiatic cholera excepting the one, and it may yet prove fatal, and you may find the characteristic symptoms of cholera Asiatica in a case of cholera nostras, and yet the patient may recover perfectly well.

Now the sudden occurrence of the symptoms in cholera nostras is usually rather characteristic. We may, however, have the symptoms occurring less suddenly than in the cases just described or in the one which I am about to read to you. This case was that of Michael E., a labourer, aged 19, who was admitted on July 1st, 1897. He was admitted in a state of collapse. He had been at his usual work and in good health on the morning of July 1st, that is on the morning of the day on which he was admitted. Whilst working he felt sick, and vomited, and at the same time was seized with profuse diarrhœa. Both the vomiting and the purging lasted for two hours, during which time no one was aware of his condition. He was then assisted up-stairs and brought to the surgery. When he arrived there he was in a condition of collapse, with cold skin, blue lips and ears; his temperature was 95° F.; his face was drawn and shrunken, the pulse was weak, and was only partially felt at the wrist. He complained a good deal of abdominal pain, and the fingers and knees were cramped and stiff. He drank water, but shortly afterwards vomited it again in a somewhat peculiar way; it was ejected with such great violence as to pass nearly eight feet across the room in which he was then lying. His respirations were sighing. He had always been a healthy man, and was said to have had no fever or other illness. There was no history of his having partaken of unsound food, so that the causation of the attack could not be traced. The family history was good. After admission he began to improve, but when I saw him in the middle of the day his condition, although rather better than it was when he was admitted, was still very bad indeed. His face was

still drawn, skin still cold, the abdomen was retracted, and the respiration was still sighing. He had passed a motion of a peculiar character; it looked almost like frog's spawn, but of a curious colour. It was a sort of pinkish-brown colour, and probably consisted of mucus. On account of the irritability of his stomach and intestines, I did not think that there was much chance of anything given either by the mouth or rectum being absorbed, and I consequently ordered him a subcutaneous injection of one-hundredth of a grain of atropine. This was ordered so as to neutralise the poison which I supposed to have been acting upon him, and to be producing the symptoms. At the same time he was ordered to have an enema of water simply coloured with permanganate of potash, in order to destroy any bacilli that might be present in the intestine, and that might be likely to manufacture more poison, as well as possibly to destroy any alkaloids that might be present in the intestine itself. After this injection he had no further diarrhœa, and after a second injection of atropine he was very much improved indeed, and about eight p.m. on the same night he was almost well. The face became full, the colour good, and the pulse also became full and regular.

The next case is that of a man, Arthur M., aged 17, who was admitted on June 15. Four days before admission he had been suffering from headache, pain in the epigastrium, and diarrhœa. These symptoms continued till admission, and then he had vomiting also. When I saw him he was complaining of severe headache and pain all over the abdomen; his face was drawn, his eyes were sunken, his temperature was 96°, and yet he had a pulse of 120 per minute. The tongue was covered with a very thick coat, the bowels had been very loose, the spleen was not felt, and the abdomen was not tender. He was treated in somewhat the same way as the previous case, but not precisely. The first thing that was done with him was to try and eliminate from the intestines both the poison and the microbes which might be forming it; and in order to do this two drachms of castor oil were administered, and along with this were given ten minims of tincture of opium in order to quiet the intestine. After that he had twenty-five minims of tincture of belladonna with a compound bismuth draught. He had also belladonna fomentation to the abdomen. The next day the dose of belladonna was increased to ten minims every four hours, and this was continued up to June 21. By this time the patient's symptoms had nearly

all passed away, and he was feeling perfectly well; on the 25th he got up, and on the 27th he was discharged cured.

Now these symptoms are very like those produced by certain classes of poisons, both mineral and vegetable. The best example of such a mineral poison is arsenic, and of a vegetable poison, poisonous mushrooms. Those two kinds of poison give rise to symptoms very much like those that we have found in the cases I have just described, but in them we could not trace either arsenic or poisonous mushrooms. In fact, we found it impossible to trace any cause for the symptoms. At the same time, we may conclude that these symptoms were due to some kind of poison having an action very much like that of poisonous mushrooms.

Many years ago I pointed out that the symptoms of cholera Asiatica were almost identical with those produced by muscarine, the poisonous alkaloid obtained from poisonous mushrooms, and I then suggested that the administration of atropine might prove useful as a means of antagonising the cholera poison just as it would antagonise the poison of mushrooms.[1] It was on account of the similarity between the symptoms occurring in the cases which I have mentioned, that I tried belladonna and atropine; belladonna in the one case where I supposed it might be absorbed because the symptoms were not so severe, and atropine in the other case where absorption from the stomach or intestines seemed to be very unlikely on account of the violence of the vomiting and the purging.

Now it was found some years ago that during the decomposition of albuminous matters various poisons are formed, namely, choline, neurine, and muscarine.[2] It is quite probable then that the cause of the symptoms observed in our cases was actual poisoning. These people were poisoned by an alkaloid just as distinctly as if they had swallowed a lot of poisonous mushrooms and been killed or made ill by the poison they contained; but in them the poison was probably not preformed in the food which they took, but was actually formed in the intestines of the patient by the decomposition of albuminous matters caused by bacteria. We know but little about the bacteriology of cholera nostras, and even the pathology of Asiatic cholera has not been fully determined. Every one is now agreed, I think, that the symptoms of Asiatic cholera are due to some toxin, and this toxin is formed by the agency of certain

[1] Lauder Brunton, *Brit. Med. Journ.*, Nov. 14, 1874.

[2] Brieger, *Ueber Ptomaine*, p. 31 : Berlin, Hirschwald, 1885.

bacilli, and more especially by the so-called comma bacilli of Koch, but this comma bacillus has not a monopoly of producing Asiatic cholera. It generally seems to be present; but D. D. Cunningham found in a number of cases which he observed and collected, that, although the clinical symptoms were identical, the cholera bacillus was not to be found in the dejecta of the patients, and he found various other bacilli. He separated no less than eleven kinds, all of which might fairly claim to be cholera bacilli. Now, in the case of cholera nostras, we know, perhaps, even less about the bacteriology of the disease than we do in the case of cholera Asiatica. There are two bacilli that are said to have caused cholera nostras; the one is known as Finkler-Prior, which has an appearance something like the ordinary comma bacillus, and you will see from the specimen under the microscope that it has a slightly curved appearance. The other one was found by Dr. Klein to be present in milk, and this bacillus is not destroyed even by boiling the milk, because it forms spores which may resist the boiling unless this be fairly complete, and unless it be repeated so that the milk is actually sterilised. Dr. Klein has given to it the name of Bacillus enteriditis sporogenes, on account of its causing enteritis, and having the power of producing spores. Whether either of these is the real cause of the decomposition of albuminous matters, and of the formation of toxins and muscarine, remains a subject for further investigation; but, at any rate, that is all we know about it up to the present moment.

The prognosis in cases of this sort is generally good, but, as I told you when speaking of the case at Kew, they do not always get well. They may die, but in the great majority they recover; and even in the very severe case of Michael E., the patient was, apparently, beginning to recover even before he got the atropine, although I think that the injection of the atropine probably helped him very considerably, and perhaps made all the difference in his case, because when I saw him before the injection he was still very ill, so ill that I thought it very doubtful indeed whether he would get round.

Then as to the treatment of such cases. First of all, the prophylactic treatment. You can readily see that if you get pure albuminous materials without the bacilli into the intestine they will be digested in the ordinary way, and will probably give rise to no mischief; that if you give non-nitrogenous materials such as bread and butter along with the bacilli, the bacilli will not have the

material to work upon, and they will not be able to form those toxins, and so again you may get no result. But if you get albuminous materials together with the bacilli, then very likely alkaloidal bodies will be formed, and poisoning will occur. Very probably it is because one is so very apt to get a number of bacilli introduced into the body that diarrhœa is so general during summer, because there are a great many materials which are often consumed during summer, which contain bacteria, and probably they are very numerous and of different kinds. For example, to give an illustration of what I mean, if any of you were to take a meal containing, let me say, steak with bread and butter, or a potato, then you would be all right because this would be all thoroughly cooked, and there would be no decomposition of the albuminous materials. Supposing, again, you take a meal of tea, bread and butter, and some fruit which is over-ripe and decaying, containing, let us say, a number of microbes; again no harm will be done because the tea, the bread, and the butter do not afford the microbes the albuminous material, from which they may form these toxins. If, however, you take a mixed meal containing meat or eggs along with over-ripe and decaying fruit, the meat or the eggs will afford an albuminous material from which the bacteria contained in the decayed fruit may split off toxins, and then you may get a case of cholera nostras. In order to avoid it then, one great thing is to avoid over-ripe fruit, unless this has been thoroughly cooked; and one sees that people generally are aware of the danger because they are chary of taking over-ripe fruit, knowing that consuming such is apt to lead to pain and diarrhœa. The peculiar bacterium that Dr. Klein investigated apparently occurs very often in milk, and even when the milk has been curdled it is contained in the whey, and if the whey be boiled it will still prove poisonous, because the spores are still present in the whey, and when swallowed they develop and yield the bacteria which caused the poisoning. One therefore requires to be exceedingly careful about milk in hot weather, and sometimes it may be possible to trace the occurrence of cases of cholera nostras to milk or cream. I did not know about the researches of Dr. Klein upon this bacterium when I was investigating the case of Michael E., otherwise I might have made more careful inquiries as to whether he had not had some milk in the morning or evening before admission. We did not go carefully into that question, but had we done so we might have found milk to be the cause of the disease in his case.

Curative treatment divides itself into two parts. The first is to evacuate any bacilli that may be in the stomach or intestines, and to kill them if you possibly can by the use of disinfectants. The second part is to neutralise the poisons which are giving rise to the symptoms. Now in my own case the bacteria seemed to have become evacuated simply owing to the profuse secretion by the bowel. By the violent movements in vomiting most of the mucus that lines the stomach was probably evacuated and most of the bacilli with it, and owing to the profuse secretion from the intestine the bowel was completely washed out and the bacteria seemed to have passed out along with it, so that there was no further disturbance. But in cases where this does not occur you often wash the bowel out thoroughly by giving some substance that is likely to clear it out without giving rise to irritation, and more especially castor oil is preferred in these cases because it does not tend to cause any special irritation. One would imagine that salts ought to be very efficient in the treatment of these cases, but practically Epsom salts and other saline purgatives do not seem quite so satisfactory as castor oil. The castor oil seems to clear the bowel out thoroughly, but the salts seem to tend to increase the intestinal secretion, which the poison itself has already stimulated to quite a sufficient extent. One of the best modes of treatment, therefore, is to give a dose of castor oil and along with it five to ten minims of tincture of opium, so that, after the bowels have been cleared out by the castor oil, you may have the residual sedative tendency of the opium remaining behind and tending to check both the painful griping and to check the peristaltic movements of the intestine, so as to stop both pain and purging. In the case of Michael E., where the danger seemed to me great, I thought that probably the best plan was to wash the bowel out with a large enema, tingeing it simply with a little permanganate of potash in order to destroy bacteria and any toxins; and this seemed to answer very well, because the patient had no diarrhœa after the enema was evacuated. Then in regard to the counteracting of the effect of any poison that has been formed, I believe that belladonna and atropine are the two best things; that they are better even than opium. The advantage of opium is that it lessens pain so greatly, and it also tends to check purgation. But purgation in such a case as this probably depends upon a definite poison, and if we can find a drug that will antagonise the poison we shall gain our end much more readily than if we simply use another drug

which has a sort of general sedative action but does not completely antagonise the poison. Opium or morphine has the general effect of soothing the intestine, but neither of them antagonises muscarine in the same way that atropine does. Therefore, I think that in cases of cholera Asiatica, or cholera nostras, atropine and belladonna probably afford the best means that one can adopt for the purpose of counteracting any poison.

ON THE USE OF ATROPINE IN CHOLERA.

Paper read before the Royal Medical and Chirurgical Society of London June 13, 1893.

(Reprinted from vol. lxxvi. of the *Medico-Chirurgical Transactions.*)

I HAVE to ask the indulgence of the Society for bringing before it a paper founded upon only one case. My excuse for doing so is that the case is one for which I have been obliged to wait nearly twenty years, and the probability of a return of cholera during the present year is so great that it is well to discuss all means of treatment which are likely to be useful in the disease before it actually begins to spread again, either in this country or on the Continent.

In 1873, in a paper read before the British Association at Bradford, I pointed out the great likeness which exists between the symptoms of cholera and those produced by poisoning with muscarine; and I then suggested that as atropine completely antagonised the action of muscarine, and prevented death from what would otherwise have been a fatal dose, it might possibly be useful in the treatment of cholera. At that time the pathology of infective diseases was not understood as it is now. One could not point to any organism as the cause of cholera, nor did our knowledge allow of any distinction being drawn between pathogenic microbes and the poisons which they produce. I did not, therefore, attempt to discuss more closely the nature of the poison. While the infective nature of cholera and its transmission from place to place seemed to point to a microbe as its cause, yet Lewis and Cunningham,[1] in a paper published in the year subsequent to mine, announced that they had failed to find any microbe in the blood or tissues, but had succeeded in producing symptoms of gastro-enteric irritation by the injection of boiled cholera dejecta into the blood of animals. These observations of Lewis and

[1] *Nature of Agent or Agents producing Cholera*, Calcutta, 1874.

Cunningham appeared to show that the cholera dejecta contained the poisonous substance quite apart from any living organism which might be present in them. Since that time the researches of Koch have shown that the so-called comma bacillus is the organism most frequently found in cases of cholera, but according to Cunningham[1] other varieties of bacillus may produce symptoms indistinguishable from those of cases where the true comma bacillus is found. We may, therefore, regard it as certain that a micro-organism is the cause of the disease, although it is quite possible that this may not always be of the same character; and it is unnecessary to discuss this subject further at present, inasmuch as the subject we have to deal with to-night is not so much the effect of drugs upon the organism which gives rise to the disease as the treatment of the symptoms which the patient presents.

It is now, I think, generally agreed that these symptoms are not caused by bacilli themselves which remain in the intestine, and do not pass into the tissues, but are rather due to some poison which these bacilli produce, and which, after absorption into the circulation, acts upon various parts of the organism. When we come to inquire into the nature of this poison we find that opinions are divided about it as well as about the bacillus which generates it. According to Hueppe it is a substance resembling peptones in its physical and chemical reactions, but differing from them in this respect, that its activity is destroyed by boiling. It is evident from this statement that the substance regarded by Hueppe as the poison is not the same as that with which Lewis and Cunningham were dealing in their experiments with fresh cholera dejecta. I am therefore at the present moment, notwithstanding all the work which has been done upon cholera, unable to speak much more definitely about the poison than I could twenty years ago, and I may therefore fairly quote from my paper read at the British Association at Bradford, and say, "The cause of cholera is now generally admitted to be a poison of some sort, which can be conveyed about from place to place and transmitted from one person to another, through the medium of the evacuations, which either get into water and are drunk, or become dry and are taken into the mouth and nostrils in the shape of dust. Some even yet are inclined to hold that cholera results rather from peculiar atmospheric and other conditions than from the presence of a

[1] D. D. Cunningham, *vide* "The Bacteriology of Cholera," by A. Crombie, M.D., *Practitioner*, vol. xlvii. p. 330.

specific poison; but the fact that the disease may be conveyed from one infected locality to numerous others by a single individual, breaking out where he has stopped, and passing over those places which he has only travelled through, although those may present apparently identical conditions of air, sea, and water, shows conclusively that an outbreak of the pestilence cannot be due to these latter circumstances alone. Nor will the mere presence of the poison always produce cholera, for those who are exposed to contagion do not all become affected, and even those who have swallowed cholera stools, in which the poison is supposed to be present in its most concentrated form, have sometimes escaped with impunity. It would appear that two conditions are required, viz. the presence of the poison and the existence of a proper soil for its development. In other words, it would seem that the poison does not produce its usual effects even when it has entered the system, unless the blood and tissues are in such a state that it may act upon them. The nature of this state we cannot exactly define, but its presence seems to be due in great measure to those conditions of atmosphere and soil which some assert to be the immediate cause of the disease, but which in reality only predispose to it.

"Without entering into this question at any greater length, I shall assume that cholera is caused by a specific poison acting upon an organism which has become in some way or other susceptible to its influence. The effects of the poison upon the body may be summed up in few words. It produces irritability of the digestive canal, immoderate secretion from the intestines, and lessened circulation both through the lungs and the body. Bearing in mind these actions, it is perfectly easy for any one to deduce from them all the symptoms which are observed in the state of cholera collapse. From the irritability of the stomach and intestines there is constant vomiting and purging. The secretion from them is so profuse that the whole intestinal canal is speedily washed clean out; the stools are no longer feculent nor even tinged with bile, but consist of the secretion alone, pure and unmixed, and resembling rice water in appearance. The blood is thus drained of its fluid parts, and the consequence of this is intense thirst, which adds greatly to the sufferings of the patient. The blood itself, instead of coursing rapidly through the vessels as it does in health, stagnates in the great veins of the thorax and abdomen; the left side of the heart, instead of receiving from the

lungs a full supply of well-aërated blood which it would propel through every part of the body, receives only a scanty driblet which leaves it almost collapsed; the arteries which proceed to the body are so empty that when they are cut across hardly a drop of blood flows from them; and even when a tube is passed through the carotid artery and aorta right up to the sigmoid valves of the heart, as was done by Diffenbach, no blood can be drawn from it. The warm blood from the interior of the body, which usually circulates in the vessels near the surface, imparting to it the plumpness, warmth, and rosy hue of health, stagnates in the abdominal veins, and leaves the skin shrunken, pale, and cold; while that in the interior of the body, being no longer cooled by circulation near the surface, becomes hotter and hotter, till the internal temperature of the unfortunate patient is higher than it usually is in high fever, though his skin and breath are cold as ice. The blood which fills the small cutaneous veins, being no longer driven forward by fresh supplies from the arteries, becomes completely deoxidised and black, imparting to the surface a livid hue. So dark does the blood become that it assumes the colour of bilberry juice, and the colouring matter leaves the corpuscles and tinges the serum. It still retains its power to take up oxygen and give off carbonic acid, but notwithstanding this it passes so slowly through the pulmonary vessels that only about one-third of the usual quantity of carbonic acid is given off from the lungs, and little oxygen being taken in, there is a distressing feeling of want of breath. The voice at the same time is hoarse, low, and weak, but this seems to be simply a consequence of the general exhaustion of the patient.

"Such are the symptoms of cholera, all rising from disturbance of the circulation and excessive intestinal secretion. The remedy we seek must, therefore, be one which has the power of removing these conditions. It may be thought that the only way to do this is to eliminate from the body the poison which is producing these results, and that so long as it is still circulating in the blood any remedy which is simply intended to counteract its effects will be administered in vain. But the researches of Fraser and others on antagonism have shown us that the elimination of a poison is not required in order to prevent its injurious or fatal action, for the administration of an antidote will deprive it of its hurtful power, and as it is with other poisons, so may it be with cholera."

If we compare these symptoms with those of poisoning by muscarine, as described by Schmiedeberg, we find a remarkable resemblance between them. They are profuse secretion of tears and saliva, very violent retching and vomiting, and diarrhœa with much griping. There is contraction of the pupil, very frequent and laboured breathing, and in some animals a rapid, and in others a slow pulse, muscular weakness, cessation of the respiration, and death. On making some experiments as to the cause of dyspnœa, I came to the conclusion that the vessels of the lung were contracted by the drug, so that the blood could not readily pass from the right to the left side of the heart. After the administration of muscarine I saw the right side of the heart become distended, the lungs become pale, and the left ventricle become contracted. The administration of a small dose of atropine caused a complete change in these appearances. The right ventricle emptied itself, the lungs became rosy, and the left side of the heart again became filled. The effects led me to think that atropine might be a useful remedy in cholera, but I had no opportunity of testing this myself until last August, when two cases arrived in London from Hamburg and were brought to St. Bartholomew's Hospital. One of these was a man, Gustave Rosenbaum, æt. 35, who left Hamburg on August 27, apparently quite well, but was very sick and suffered from diarrhœa during a rough passage. He landed at Harwich on the morning of August 29, and came on to London the same morning. He seemed fairly well during the day. During the evening he was taken ill, had diarrhœa, with pains across the back and cramps down the legs chiefly in the right. He had diarrhœa all night. The motions were loose but coloured. On the morning of the 30th he vomited, had no diarrhœa after 11 a.m., but suffered much from pain across the back, and was brought to St. Bartholomew's late in the afternoon. Having been summoned to an urgent case of pneumonia at some distance off in the country, I did not see the patient, but I heard he was to come in, and I discussed the treatment with the house physician. When admitted he had a sallow, grey look, his eyes were sunken, pupils equal, not contracted. His pulse was scarcely perceptible at the wrist, 148, very feeble; the respiration was sighing, 56; the temperature 95·8°. The first sound was distinct at the apex, the second sound was not heard, and both sounds were very feeble at the base. The arms were cold, and the fingers were cold and dusky. He was ordered Liquor

Hydrarg. Perchlor. half a drachm, spt. of chloroform 5 minims, and water up to an ounce every four hours, to act as an intestinal disinfectant. At ten o'clock he was very restless, complained of great pain in his back and the calves of his legs, and was ordered the mixture every two hours. At 1.20 a.m. on the 31st he was still very restless; his pulse was perceptible at the wrist, 160 per minute; the respirations were 40. The bowels were open twice, once into the bedpan and once into the bed. The motions were hardly coloured at all. He passed a small quantity of urine, which contained a small cloud of albumen, and was acid and high-coloured. At 2.15 the bowels were open, then again at 2.45, and again at 3. At 3.30 he asked for the bedpan, and then suddenly collapsed and died. Although the motions up to the last hardly presented the typical rice-water appearance, the comma bacillus was found in large numbers by Mr. Cautley in the intestine, and Dr. Klein confirmed the observation.

On post-mortem examination the mucous membrane of the intestines was rather pale, with a few reddish patches on the lower part of the small intestine. The blood in the veins of the neck and of the heart was thicker and blacker than usual. The spleen was normal, and there was only one mesenteric gland at all enlarged. The other organs were merely normal.

At the same time as this patient his daughter, Casperina R—— æt. 3, was brought into the hospital.

She was taken ill upon August 24, with spots on her face and diarrhœa. From this she appeared to recover, but remained somewhat languid. On the 27th she left Hamburg. She was sick on board ship, but had little diarrhœa, and on August 29, when she came to town, was fairly well. On the morning of the 30th she was taken ill with frequent diarrhœa and violent vomiting. The motions were slightly coloured, and there was no pain. On admission to St. Bartholomew's on the evening of the 30th she was dusky, with pale lips and sunken eyes; the pupils were equal and of moderate size, the conjunctivæ injected. The legs and arms were cold, clammy, and dusky. The tongue was moist. The pulse was 143, feeble. The respiration was 39, sighing, the temperature 97°. The impulse of the heart was feeble, the first sound absent at the apex and the second at the base.

The child was ordered milk, soda-water and brandy, Liq. Hydrarg. Perchlor. ♏xv, Spt. Chloroform. ♏ij, and water up to half an ounce every two hours. At 11 o'clock the child was

not so well as on admission. The bowels had been open three times, and the motions were of a pale brown colour, considerable in quantity, and contained no solid matter. At 1.30 the extremities were cold, lips very pale, pulse 152, easily counted; resp. 24, long-drawn and sighing; no more diarrhœa. On August 31st I saw the child at 9 a.m.; the pulse was better, hands warmer, no diarrhœa. At 1 p.m. the pulse was feebler, the eyes were sunken and glassy, no urine had been passed. The lips were not so blue; the respiration was 20, not so sighing; pulse 124. At 5.30 the child was in the same condition, but the hands were colder; the pulse was 140. One two-hundredth of a grain of atropine was then given subcutaneously. In ten minutes the child appeared flushed, the pulse went up to 160, the respiration to 24, and was not so sighing. For a short time after the injection the child slept quietly. The bowels were not open, and no more urine was passed. There was some sickness, and in consequence of this the Liq. Hydrarg. Perchlor. was stopped, and Bism. Subnit. was given instead. Just before midnight there was more vomiting and sighing respiration, and a quarter of a grain of calomel was ordered every two hours. At 3.45 the respirations had sunk to 12, and they were long-drawn and sighing. The pulse was 140 and the surface very cold. One four-hundredth of a grain of atropine was then injected subcutaneously. In a quarter of an hour the hands became rather warmer, the pulse remained at 140, but the respirations rose to 18 per minute. Small enemeta of water, half an ounce, were also given. During September 1st the condition varied a good deal, but the respiration did not again sink so low as before, although towards evening it fell to 15. There was considerable sickness, but only one motion in the early morning. On the 2nd the child was in the same condition, passed a greenish-coloured motion with some solid matter in the early morning. From this time the child steadily improved until she left the hospital on September 8th, completely recovered.

In this case the injection of atropine acted as a powerful stimulant when the respiration appeared about to fail, and increased the rate of breathing and the warmth of the surface. It did not appear to have any influence upon the retching, vomiting, or diarrhœa. This is precisely what one would expect from the experiments which Dr. Pye-Smith and I conducted a number of years ago, and which was reported to the British Association in 1874, 1875, and 1876. In the first series of these experiments

Dr. West was associated with us in the committee of the Association. The whole of these papers were reprinted, and the pathology and treatment of cholera in general were discussed by Dr. Pye-Smith and myself in the *Practitioner* for November 1884, and in subsequent numbers.

In summing up our conclusions regarding treatment, we observed that two desiderata in the treatment of cholera were (1) an antiseptic to destroy the cholera bacillus and prevent it from forming poisons in the intestine, and (2) a remedy which would antagonise the action of the poison after its absorption from the intestine.

In the treatment of the case which I have described, the perchloride of mercury and calomel were used for the purpose of disinfecting the intestine, the atropine was given for the purpose of antagonising the action of the cholera poison upon the circulation and respiration. I have already mentioned that we do not yet know the exact nature of the cholera poison; and it seems not at all unlikely that there are more than one, because, as I have already pointed out, Hueppe and Cunningham appear to have had different poisons, both of which they had obtained from cholera dejecta or cultivations from them, and M. Villiers obtained from the intestinal contents of cholera patients an alkaloid which had a marked action upon the heart, sometimes slowing it greatly, and at other times greatly increasing its rapidity. Claude Bernard has stated that in some cholera patients slowing of the heart was observable for some days before the attack, and this rather points to the presence in the circulation of a poison having an action like muscarine. It is a well-known fact that some mushrooms are intensely poisonous, while others are not, but occasionally some species become poisonous when grown under certain conditions. It seems not impossible, therefore, that the cholera bacilli, even if we suppose them to be originally of the same nature, may not only undergo variations in their appearance, but may form poisons according to the conditions which they meet in the intestine. Amongst these it is by no means improbable that muscarine itself may actually be formed, inasmuch as Brieger has shown it to be not an uncommon product of albuminous decomposition during putrefaction; and, if so, atropine is likely to be useful in certain cases. But atropine cannot be looked upon at all as a universal remedy for cholera. It is not likely to effect the profuse intestinal discharge, and will probably, therefore, do but little good in cases

where this is very profuse. But in such cases as those two which I have described, where the intestinal discharge was scanty and the vascular symptoms were pronounced, atropine may be useful, and undoubtedly in the case of the little girl, Casperina Rosenbaum, a marked improvement appeared to follow immediately upon its injection, although a relapse occurred subsequently. Before concluding I may mention some interesting observations of Alt, who has found that not only is the venom of snakes excreted from the stomach when injected subcutaneously, but that toxalbumins of cholera are excreted in a similar manner, and that washing out the stomach may also be useful as an adjunct to other treatment. In a paper that I wrote in the *British Medical Journal* I pointed out the probable utility of washing the stomach out in case of a snake-bite, but Alt's observations were only published a monht or two ago, or I should have tried the effect of washing out the stomach in the case of Casperina Rosenbaum, either with water, dilute saline solution, or with a weak solution of permanganate of potash.

The general treatment of cholera is, however, too wide a question to go into here, and I must be content with simply pointing out the possible use of atropine as a cardiac and respiratory stimulant in some cases of the disease.

In conclusion, I desire to acknowledge the careful attention of Dr. Batten, house physician, and to thank him for his laborious observation of the cases.

St. Bartholomew's Hospital (August 30, 1892.)—Casperina R—, æt. 3.

History.—Child taken ill six days ago, had spots on her face, had diarrhœa, after medicine got better. Left Hamburg on Saturday, August 27, three days ago. Somewhat languid after the diarrhœa. One hundred and eleven on board ship. No diarrhœa to speak of. Fairly well on August 29, when she came to town. Yesterday evening child slept fairly well. This morning child first taken ill. Had frequent diarrhœa, motions slightly coloured. Child vomited after everything given except Mellin's food; no pain.

Family history.—Mother well. Father choleraic symptoms. Only child. *Past illness.*—Always healthy.

Present condition.—Dusky, eyes sunken, lips pale, tongue moist. *Pulse* 143, feeble, easily countable at the wrist. *Respiration* sighing, 39, long-drawn inspirations at times. *Temp.* 97. *Eyes* very

much sunken, pupils equal, moderate size, conjunctiva injected. *Arms:* hands cold, clammy, dusky colour. *Chest:* breath-sounds natural. *Heart:* impulse feeble, absence of first sound at apex and second sound at base. *Legs* cold, clammy, blue. *Urine. Abdomen* resonant, no tenderness; liver not enlarged.

11.10.—Child not so well as on admission. Bowels opened three times since admission; motions pale brown colour, no solid matter, a good deal in quantity. *No vomiting.* Ordered milk, soda-water and brandy, and Liq. Hydrarg. Perchlor., ♏xv; Spt. Chloroform., ♏ij; Aq. ad $\frac{1}{2}$ oz., 2dis hor.

1.30.—Extremities cold, pulse easily countable at wrist, 152. *Resp.* 24, sighing, long-drawn; no more diarrhœa; lips very pale.

August 31, 9 a.m.—Pulse better, hands warmer, no diarrhœa.

1 p.m.—Pulse not so good as the morning. Eyes sunken. Child taking not so well. No urine passed. Lips not blue. Eyes glassy. Resp. 20, not so sighing. Pulse 124.

5.30.—Child remains in same condition. Hands colder. About 1.30 passed some urine; no motion. Pulse 140. Child will not take readily; injection of $\frac{1}{200}$ gr. of atropine subcutaneously.

5.40.—Child appears flushed. Pulse 160. Resp. 24, not so sighing.

7.30.—The last dose of Hydrarg. Perchlor. was given at 4.30. It was not repeated at 6.30 on account of the sickness. Ordered Bismuth. Subnit., gr. iss; Sod. Bicarb, gr. iiss; Spt. Chlorof., ♏iiss; Aq. Arni, ℥ij p. r. n. for the sickness. Child vomited about 1 oz. Pulse 132. Resp. 20. Not so flushed. Child apparently slept quietly for a short time after the injection. Hands fairly warm. Bowels not opened. No more urine passed.

10.15.—Child vomited again. Pulse 140, resp. 24.

September 1st, 12.15.—Child vomited again at 11.45. Pulse 120, respiration sighing. Ordered calomelanos gr. $\frac{1}{4}$ secundus horis.

1.20.—Not vomited again, hands rather colder. Pulse not so good, 120.

3.45.—Child vomited again at 3.15; about 5 oz. of milk given. Resp. 12, long-drawn; pulse 140. Injection of $\frac{1}{400}$ gr. of atropine.

4.—Hands rather warmer. Pulse 140, resp. 18. Enemata of $\frac{1}{2}$ oz. of water.

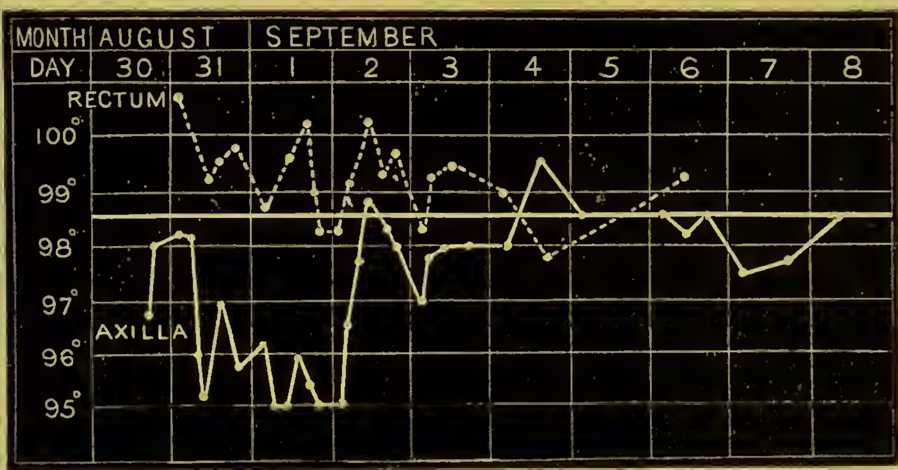
September 1, 9.50.—During the past six hours the child has taken only 6 dr. of milk and soda-water; the enema given at four o'clock was retained as well as the one given an hour later. The

one given at 6.15 was returned with loose, light-coloured motion. The child seemed brighter this morning. Pulse not so good, 120, fairly regular; hands cold, feet warm. Respiration more sighing for last hour, 20. No vomiting since 3.15.

12.45.—Vomited twice since 9.50. Child seems brighter. Pulse 140.

5 p.m.—Pulse much better, 108, fair volume; resp. 20. No vomiting since 12.30. Taken 5 oz. of milk and soda-water, 1½ dr. of brandy, two enemata of ½ oz. each. Passed over 1 oz. of urine at 10.50; urine acid, very faint trace of albumen.

9.30.—Pulse not quite so good, 120. Child vomited once this evening and retched for some time afterwards. The child slept



afterwards. Taken Oss. in last twelve hours. Child rather more restless. Had arrowroot water this evening, vomited this evening after it.

11.40.—Child sleeping quietly for last two hours. Eyes shut, breathing regularly. Took 1 dr. of milk and brandy, tendency to vomit. Pulse 120, resp. 15; respiration more sighing.

2nd, 1.20—Child in same condition. Pulse 116, regular, fair volume. Dark greenish-coloured motion passed, not very offensive. Some solid matter.

10.30.—Child very much better, eyes less sunken, seems in pain at times, no vomiting since 1.35 (vomited immediately after milk). Pulse 120, respiration 28, not so sighing in character. Urine passed into bed. Bowels open very slightly.

7.25.—Taken very well to-day, nearly 1 pint. Child much better. Bowels open once. Motion light, unhealthy-looking. Pulse 120, resp. 28. No vomiting.

3rd.—Very much improved, no vomiting, no diarrhœa. Pulse 116, resp. 28; eyes much less sunken.

4th.—Child much better; has taken bread and butter, custard pudding, and bread and milk, slept well. Pulse 120, regular. Bowels open once during the night.

5th.—Pulse 112. Child quite well, taken chicken broth, sat up in bed. Bowels not open. Temperature normal.

6th.—Child quite well, bowels not open. Ordered dose of Ol. Ricini. Urine acid, 1012, no albumen.

8th.—Child quite well. Ol. Ricini acted well. Child going home.

Gustave R—, æt. 35.

History.—August 30—Left Hamburg on Saturday, August 27, quite well when starting, rough passage, very sick during the voyage, had diarrhœa, landed at Harwich on Monday morning, August 29, came to town same morning, seemed fairly well during the day. In evening taken ill, had diarrhœa, pain across the back and cramps down the legs, most in right. Diarrhœa continued all night, motions coloured, loose. This morning vomited after medicine given by doctor, no diarrhœa since 11 a.m. this morning. Great pain across the back.

Family history.—Child taken ill while at Hamburg, got well again, taken ill again last night.

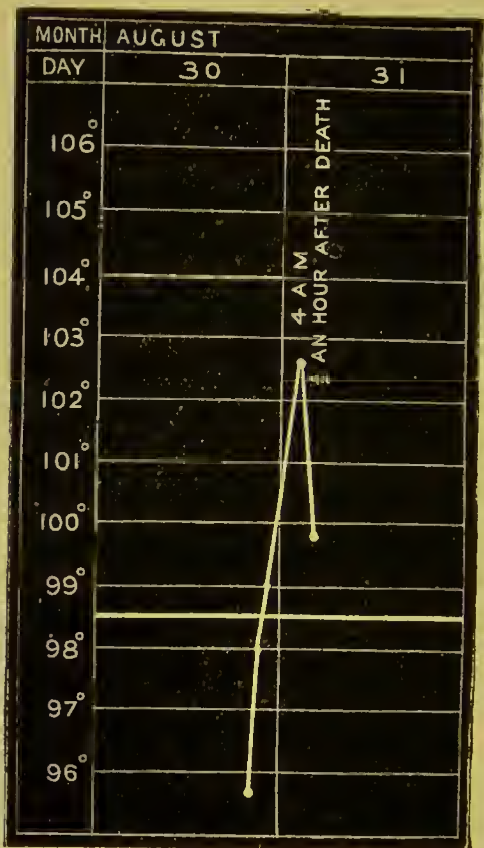
Present condition.—Sallow, grey look, eyes sunken, pupils equal, not contracted, pulse scarcely perceptible at wrist, 148, very feeble. *Resp.*—Sighing, 56. *Temp.*—95·8°. *Lips* dry, very poor colour; tongue moist, not furred. *Eyes* very much sunken. Cheeks hollow. *Chest* thickly covered with hair, percussion good all over. Breath sounds natural. *Heart.*—Apex-beat distinctly felt in fifth interspace. *Sounds.*—Distinct first sound at apex, second sound not heard; sounds very feeble at base. *Abdomen* not retracted, resonant all over, except hepatic dulness. *Bladder* not distended above pubes. No tenderness on palpation, not retracted, warm. *Arms* cold, fingers cold, dusky. *Legs* fairly warm, feet rather cold, knee-jerks not obtained. Urine passed into bed. Was ordered Liq. Hydrarg. Perchlor. ʒss, Spt. Chlorof. ♏v, Aq. ad 1 oz. 4tis hr.

10.15.—Very restless, complains of much pain in his back, and some in calves of his legs. Ordered mixture every two hours.

31st, 1.20 a.m.—Still very restless, pulse perceptible at wrist

Passed about 4 oz. of urine, B. O. twice, once into bedpan, once into bed. Taken 23 oz. milk, 1 oz. brandy. Hands cold, less pain in back, motions watery, hardly coloured. Pulse 160, resp. 40.

3.30, patient suddenly collapsed. Bowels open just at 2.15, and then again at 2.45, and again at 3 o'clock, and immediately before collapse asked for bedpan. Had taken medicine at 3, seemed no worse, very restless. Motion light brown colour, no solid matter. Urine high-coloured, fair cloud of albumen, acid.



Post-mortem made nine to ten hours after death.

External appearances.—A medium-sized man. Body moderately well nourished. Abdomen neither retracted nor swollen. Face and eyes sunken. Marked rigor mortis. The blood in the veins of the neck and in the heart was thicker and blacker than usual.

The examination of the head and neck was not allowed. *Lungs* normal, light and spongy in texture, not engorged. *Heart* normal, soft clot in the cavities, weight 10 oz. *Abdomen. Peritoneum.*—No peritonitis. External surface of the intestines rather dulled in appearance, and thought by some of those present to be soapy to

the touch. General colour rather pale than otherwise, but vessels injected somewhat. The same external appearance throughout all the length of intestine. *Stomach.*—Normal, contained some bilious fluid. *Intestines.*—In upper part of small intestine yellow fluid like the bile-coloured stuff usually found here. Lower down the fluid became paler and thicker (pale greenish yellow), but it was at no point colourless nor "rice-water" in character. The mucous membrane was rather pale in colour with a few reddened patches in lower part of small intestine, but otherwise looked normal. *Liver.*—Rather small, otherwise normal, weight 44 oz. *Spleen.*—Small, weight 5 oz., section normal. *Abdominal lymphatics.*—Only one gland was at all enlarged, and that not greatly, viz. a mesenteric gland near the valve. *Kidneys.*—Normal in appearance though small, weight 10 oz. the pair.

(For report of the discussion on this paper, see *Proceedings of the Royal Medical and Chirurgical Society*, Third Series, vol. v. p. 122.)

SPRUE.

A clinical lecture delivered at St. Bartholomew's Hospital.

(*Edinburgh Medical Journal, February*, 1900.)

GENTLEMEN,—If you go into Rahere Ward and look at the patient in the State bed and the one in the adjoining bed you will find two cases which resemble one another in a good many respects, although they differ very much from one another in some most essential features. You will find that both men are lying flat on their backs, looking apathetic. They do not care to move, their faces are thin, and their eyes seem to be falling into their sockets; but if you go into the cases a little more fully, and read the description at the head of the beds, you will find that the case in the State bed has lasted for years, and the case in the adjoining bed has lasted only for a few weeks. You will also observe that the case in the State bed is one where there has been little or no rise of temperature, that the temperature, indeed, has been, as a rule, subnormal, whereas in the other case the temperature has been much above the normal. The case in the State bed is one of a somewhat rare disease in this country, namely, sprue, and that in the adjoining bed is one of typhoid fever. Both those diseases are characterised more or less by diarrhœa, but the diarrhœa in both may be to a certain extent absent. Sprue is a disease, as I have said, which is somewhat rare. Cases resembling it are exceedingly common in foreign countries, more especially in India, in Ceylon, in China, and in the Straits Settlements, but, when you come to look up the literature on the subject, you will find that there is a considerable difference of opinion as to what sprue is.

There are two diseases about which authorities are disagreed, but upon which the community seem to be in accord in dividing from one another, although medical men are inclined to regard them as one. These are the diseases known popularly as "Ceylon

sore mouth" and as "hill diarrhœa." Now, the reason why the populace have divided those diseases from one another is because the symptoms are more prominent in the mouth in the so-called Ceylon mouth or true sprue, and in the intestine in the Indian hill diarrhœa.

In the early stages of sprue the mouth is very sore, and very frequently also the anus is affected, although there may be not much diarrhœa at the time. In the case of the Indian hill diarrhœa, on the contrary, one may find that the mouth is not affected, while the diarrhœa is very well marked. Although, however, one is able to distinguish these two prominent symptoms, yet the two diseases may run so into one another that it may be exceedingly difficult, or even be impossible, to differentiate them, because in Ceylon sore mouth, as a rule, the soreness of the mouth is either succeeded or accompanied by diarrhœa, and in the later stages of the so-called Indian "white" or hill diarrhœa the mouth may also become affected; so that if you take at one particular moment a case of Ceylon sore mouth or sprue, and Indian hill diarrhœa, you might be unable to say which was which. More than that, I think you will probably find, on examination of the case which we have in the wards, that although it was diagnosed when he came in as a distinct case of sprue, you would very likely diagnose it, if you were to go to it now without any history of the case, as one of Indian hill diarrhœa, the reason being that when he came in there was a well-marked affection of the mouth, which has now subsided, although the condition of the intestines remains.

Now, in both those conditions which, as I have mentioned, it is so hard to differentiate, we find one common characteristic in the nature of the diarrhœa—it is that, as the popular name of the Indian affection implies, the stools are white. In sprue we find that the stools have certain well-marked characteristics; they are, as a rule, liquid, white, and frothy, the froth showing that some fermentation is going on in them. They are also frequently offensive, but they may not always be so. The characteristics, then, of a well-marked case of sprue are:—(1) That the mouth is sore; (2) the anus is sore; (3) there is well-marked diarrhœa, the stools being of a liquid, white, and frothy nature.

In Indian hill diarrhœa the same character of the motions obtains, but you do not find the sore condition of the tongue, the mouth, and the anus to the same extent. The consequence of

such an affection is necessarily malnutrition of the patient. The patient's body loses weight, his muscles lose strength, he is disinclined to move, as you will see from the patient in Rahere Ward. He looks shrunken, and, more than that, his mental and nervous systems seem to fail to a certain extent also. He is rather apathetic, does not care to move, does not like to be tormented with questions, and possibly, if you do trouble him much with questions, you may find that he is somewhat irritable. However, all these are, I think, only secondary to the malnutrition, and as patients who suffer from this disease begin to recover, both their bodily and mental condition improves.

There are some other conditions in which this whiteness of the motions is found, which has been a very great stumbling-block to many people who have been quite unable to explain the whiteness. In the case of most of them, the whiteness is due, not to absence of bile, as one would expect, but to the presence of undigested fat. You may get complete absence of bile where there is no diarrhœa. One of the most remarkable instances of this sort that I have ever seen was in a patient whom I saw just ten years ago. He had been a good long while in Calcutta, and suffered from ague. The first symptom that he noticed, in January 1885, was absence of bile from the motions, although at that time there was no diarrhœa—the diarrhœa first making its appearance in May 1885. He got much worse, became very weak, and came to this country, where I saw him in consultation with Dr. Lyne Stivens. He was then passing motions of a very peculiar character. They were as white as arrowroot, but they were tougher than ordinary formed motions, so much so, that instead of breaking into pieces they fell into a very peculiar shape. They really looked like a snake coiled up, with the head projecting, just as if ready to strike. I should say that this gentleman was at the time upon milk diet, and the apparent absence of bile from the motions sorely puzzled me, because there was no jaundice of the skin, no darkness of colour in the urine. I thought that the liver in some extraordinary way must have had its function abolished, but I got an analysis made of the fæces by Dr. Sidney Martin, who found that the liver was doing its work, and that the motions did contain bile, although in small quantities. Biliverdine was present in an unaltered form, though only an indication of biliary acids could be obtained. If we had found the opposite of that, namely, if we had ascertained that

bile acids were abundant, but that only a trace of colouring matter was present, we would not have wondered that the motions were white, but it was not so. The bile acids seemed to be diminished, but the bile pigment was present in an unaltered form. The reason of the motions being so white was that the fat in the milk was not digested, and therefore it appeared in the motions. In the case I have just alluded to, it would seem, then, that the starting-point of the disease was rather in the absorption than the digestion of fat, and that this occurred four months before there was any indication of diarrhœa. This is, I think, interesting in regard to the pathology of the disease, which we shall presently have to consider, because in most cases the pathology of the disease is said to depend upon the alteration in the intestine. This, no doubt, is a very important point, but I think that the want of change in the fat points also, to some extent, to an alteration in the pancreas.

On looking at the symptoms more closely we find that the changes in the mouth are apparently of an aphthous nature; that you see on the tongue, first of all, a certain amount of redness and congestion. Then this redness becomes patchy, and is found to surround little vesicles. These burst and then ulcerate, and these ulcerated portions may run into one another. In this way ulcers more or less big may appear upon the tongue, and in many cases they are seen on the outside of the lips and inside of the cheeks. Thus we get what is known as the Ceylon sore mouth. The mouth is so exceedingly tender that the patients cannot bear to chew much, nor can they bear anything that is in the least irritating. For example, they cannot touch even diluted spirit or wine, on account of the soreness it causes. Pepper, condiments of all sorts, and even salt, they are obliged to go without. This tenderness of the mouth is not limited to the mouth and tongue. It goes apparently down the œsophagus, so that on taking anything irritating or hot they feel the pain or burning right down to the stomach. Once it is in the stomach they do not complain so much of pain, but they may have pain more or less over the stomach and abdomen. Then again, coming to the next region supplied by spinal nerves—to the anus—they complain of pain there. The changes that are noticed in the mouth, in the œsophagus, and in the intestine are first of all apparently denudation of epithelium. The mouth becomes more or less denuded of epithelium, as is shown in one of the sections

which Dr. Sandiland has kindly lent me, and which I show you under the microscope, the ordinary epithelium being almost entirely absent, or represented only by one layer of epithelial cells. The same denudation of epithelium appears to occur in the gullet, but does not seem to take place in the stomach, at least to any great extent. In the small intestine it does occur much, and there you will find a very peculiar condition. The bared intestine is covered with a layer of mucus. The whole intestine, moreover, seems exceedingly thin, almost translucent. I remember being very much struck by a case which I saw many years ago, and which I did not diagnose. I suppose it is now nearly twenty years ago, and at that time very little was written about sprue. It was the case of a captain who had spent many years in the China seas. He had suffered from dysentery, and returned home, and settled down in a small house near Mitcham Junction. He had chronic diarrhœa, with a good deal of pain in his abdomen. I tried all sorts of things, but the diarrhœa would not yield, and finally he died of exhaustion. My diagnosis was that the case was one of chronic dysenteric diarrhœa consequent upon an acute dysentery, and that probably I should find in the intestine ulcers or cicatrices. To my astonishment I found that there were no ulcers in the intestine, and, when I took the small intestine out, it looked like a bit of bladder. It was so thin, so translucent, and the surface of it looked as if the whole of it had been shaved with a razor until all the villi had been taken off, and thus rendered quite transparent—in fact, as if it had been prepared in imitation of a bit of parchment for writing upon. Now, it is this bare condition of the intestine, of the tongue and of the œsophagus, this denudation of epithelium, which has led Dr. Thin to give to it the name of *Psilosis linguæ vel mucosæ intestini.* This name has been chosen by Dr. Thin to designate sprue a disease which he considers to be entirely distinct from hill diarrhœa; but it is exceedingly difficult to be quite certain of the diagnosis in particular stages of the disease, and you can only diagnose them by paying attention to those points to which prominence is given in the ordinary names given to the diseases by the lay public, namely, the soreness of the mouth in the case of sprue, and the absence of this in the case of hill diarrhœa. We know diarrhœa to be a common symptom in both.

The prognosis in both diseases is bad if they are left alone.

The patient is very apt to get weaker and weaker, and finally to die. Nor is the fatal issue, as in the case of my first patient, to be averted by the use of drugs, unless you put the patient on a particular diet at the same time. The diet, which is a *sine qua non* in treating either hill diarrhœa or sprue, is an entirely milk one. It is the same diet that we use in cases of typhoid fever; milk, and nothing but milk. The next question comes to be, how much are you to get the patient to take? Well, the answer is, get him to take as much as ever he can. A large proportion of the milk will almost certainly pass unabsorbed through the intestine, more especially will the fat not be absorbed. The sugar of milk and the proteids are absorbed to a great extent, but the fats are not. By giving him a large quantity of milk you will probably be able not only to maintain his strength, but to increase it, and after a certain length of time the patient will get well. That they do recover I know, because I have here the notes of another case where the symptoms were well marked, and where the patient, after being put upon a milk diet for a length of time, became first of all greatly improved, and now I hear is completely well, although he is a somewhat elderly man. But just as in cases of typhoid fever, patients sometimes cannot take milk, or milk is insufficient, so it is in cases of sprue. What is to be done in such cases? Well, if you cannot get enough milk down, you may try the effect of giving along with it some beef juice, or you may try the effect of putting the patient entirely upon meat juice. This treatment was actually tried, with benefit in the case that we have here; the notes of which I shall presently read. In addition to this, however, you may give them some sedative to the bowels. In the case that I mentioned a little while ago, where the bowels were not very loose, but where we had a peculiar form of motion, the medicine that was most useful was a preparation of bismuth, with the addition of some cannabis indica. This addition was made to it by Dr. MacConnel, of Calcutta, whom I saw in consultation in regard to the case. Dr. MacConnel, who is unfortunately since dead, told me that this was a formula that he had used very much in the treatment of hill diarrhœa in India, and had found it, upon the whole, to be one of the most successful. I will just write it down, because many of you may go into the army and go out to India, and may have to treat such cases. The first thing you have to do is to put your patient upon a milk diet. If he cannot take very much milk, put him to bed, so that you

take nothing out of him, and put everything into him. If he can take a lot of milk you may possibly allow him to go about, and in one case, which Dr. Thin treated, and which I saw on one occasion during his absence from town, the patient was on a milk diet absolutely for three months. In that time he laid on flesh, although he was attending to his duties as a director in a city company several times a week. The prescription I have referred to is:—

℞.	Bismuth carb. . .	gr. x.
	Sodii bicarb. . . .	gr. x.
	Tinct. cannabis ind. .	♏. v.
	Mucilag. tragacanth. .	ʒi.
	Aq. cinnamom. ad. .	℥i.

You must be careful not to forget to add the tragacanth or acacia, for cannabis indica, as you know, owes its activity to a resin, and when you mix the tincture with water, as you will do in making up this mixture, the resin will be precipitated. This mixture may be given every three or four hours, or even oftener.

In most of the cases we have been discussing, the liver is not found to be much enlarged, but, if anything, it has a tendency to be small. This is, however, not always the case, at least, not in hill diarrhœa. A man, æt. 35, consulted me in July 1888. He had been out in Afghanistan eight years before he came to me, was attacked with diarrhœa in 1880, and had suffered more or less from it for the last eight years. When I saw him he had been stationed for a couple of weeks at Colchester, and had been suffering very much from a recurrence of the diarrhœa. In his case there was a slight enlargement of the liver. I put him upon this mixture, and I also gave him some blue pills to try and act upon the liver, because it seemed to me that if there was any congestion of the liver it would tend to keep up the diarrhœa. He was not getting on quite satisfactorily, and I said to him, "There is one thing I should like to do, but I do not care to do it without a consultation." It seems so very absurd to give a man who is suffering from chronic diarrhœa, lasting several years, a violent purgative, and yet I said, "I think before we can do much we will have to unload your liver, but before we do so, I think we had better see Sir Joseph Fayrer." I took him to Sir Joseph, who quite concurred in my view, and said, "It is the best thing you can do." Sir Joseph prescribed that he should have a blue pill every other night, a drachm of sulphate of magnesia, a drachm of sulphate of soda, ten minims of dilute sulphuric acid, two grains

of sulphate of quinine, and an ounce of compound infusion of gentian every morning at seven o'clock, after the pill. Well, this cleared him out very thoroughly. The addition of the quinine and the sulphate of iron to the sulphates of magnesia and soda seems to make them much more efficacious, and the consequence was that the patient's liver went down very quickly, and after the liver had been disgorged, we found that the medicine he had previously been taking before began to act, and in a short time the patient got perfectly well.

I will shortly read the notes of the case which we have now in "Rahère," so that you may be able to look at it with more interest.

Case.—The man, æt. 35, had a long field-day in April 1896, in the course of which his company passed some stinking cesspools. From that day up to November 1896 he had irregular diarrhœa, but the stools were dark in colour; he had no soreness of the mouth, and no dyspepsia. About November 17 his regiment moved to Secunderabad, where he at once began to suffer from great soreness of the mouth. It lasted for about three days, and then he began to suffer from a fresh attack of diarrhœa. The stools were now for the first time white and frothy. With the diarrhœa, the patient had great pain in the epigastrium and over the lower end of the sternum. His abdomen became swollen; he had attacks of vomiting, and acid burning eructations rose at different times into his mouth. This is not quite the typical beginning of sprue, because in many instances the disease comes on very insidiously, whereas here it came on rather sharply. It did not come on when he reached Secunderabad, but really while he was on the way from Bellary to that station. The condition of the mouth quickly improved, and all the soreness had gone in seven days from the onset of the attack. From November 9 the diarrhœa continued up to present date. At times he was passing twenty motions a day. On March 25, 1898, he was admitted into Netley Hospital, where he improved on a diet of milk, eggs, and brandy. He came into St. Bartholomew's in May, and at that time the surface of the tongue, with the exception of a strip in the centre of the dorsum, was bright red, smooth, shiny, and moist. The bright red colour, the smoothness, and shininess, along with the character of the motion, would at first incline one to regard the case as being one of sprue, but if you look at his tongue now, you will notice that it has not got this shaved appearance; the

papillæ are not so large as they would normally be. The tongue is somewhat smoother than it ought to be. A central strip, about an inch in breadth, is covered with a dirty thin fur, and presents normal filiform papillæ, which elsewhere are absent. The buccal surface of the gums in the lower jaw and mucous membrane of the lower lip are bright red, moist, and shiny. On the lower lip, opposite the second incisor tooth on the right side, is a white patch of coagulated inflammatory exudation about the size of a pea. The white patch is surrounded by a patch of deep crimson. The pillars of the fauces and the tonsils are injected and somewhat swollen. They show no ulceration. The liver was unchanged in size, and cardiac dulness is somewhat masked by the stomach resonance; it commences at the fourth rib. The abdomen was distended, soft, and tympanic all over. That was practically the whole of the condition of the patient at the time of admission, and you will see that there is very little difference now.

The only point I wish now to mention is as to the treatment of the sore mouth and the soreness of the anus. The sore mouth may be treated with a good many different things. One is rather tempted sometimes to give some of those little tabloids, consisting of compressed chloride of ammonia, or chlorate of potash, but the difficulty about that is, that if you put one of them into the mouth it hurts too much, because, as it is dissolved by the saliva, the solution thus made is too strong. But you may use a diluted solution of chlorate of potash or borax, say five grains to the ounce, quite easily, and this sometimes relieves the patients very much. A dilute solution of bicarbonate of soda seems to help a good deal, because the bicarbonate of soda neutralises any acid that may be present in the mouth, and lessens the soreness of the tongue. Lime water also may be used as a mouth wash. The soreness of the anus may be relieved, or perhaps entirely removed, by the use of various ointments, an ointment containing bismuth for example, especially bismuth made up with lanoline. I do not know what the composition of homocœa is, but one of my patients, who came from Ceylon, told me that he found this preparation almost invariably relieved the soreness which occurred in the disease. If you find that the bismuth ointment alone does not suit, you may then put in a small proportion, say one part in twenty, of calomel ointment, or else of unguentum hydrargyri ammoniati, into the mixture of oxide of zinc and lanoline. There is one point I have forgotten to mention in regard to the non-absorption of the fat.

It might be due in great measure to the absence of bile, but the absence of colour in the case I referred to, of Mr. M., where the stools began to get white three months before diarrhœa came on, seemed to point rather to some obstruction of the pancreas. The reason that one is inclined to connect this condition of pale stools with alteration in the pancreas is, that some years ago Dr. Walker of Peterborough read at the Medico-Chirurgical Society notes of a case of white stools lasting for several years, and with no apparent impairment of the patient's health, but where after death the pancreatic duct was found to be completely obstructed Thus it would seem that in such a case as Mr. M.'s it was not the liver that was at fault, but that the pancreas had struck work and, for some reason or another, the secretion had not been poured out into the duct. In consequence of this idea some maltine was given to the patient, in order to supply a diastatic ferment, and on this treatment he improved more than upon the milk alone. In the case at present under treatment we are giving milk with liquor pancreaticus, with the idea of trying to supply a ferment which may possibly be absent.

In post-mortem examination it has been found that the pancreas is also somewhat affected, and that there is a great deal of increase in fibrous tissue, and very often vacuolation and disintegration of the cells forming the secreting structure of the pancreas. In the microscopic sections on the table you will find first of all absence of epithelium in the tongue, and a section of the ileum shows thinness of both the muscular coats, with degenerative changes in the muscular cells. In both the ileum and in the tongue this denudation of epithelium is observed, and on the ileum one generally finds also a thick coat of mucus all over the surface.

REMARKS ON THE TREATMENT OF PILES AND ALLIED AFFECTIONS, INCLUDING PRURITUS ANI.

Read before the Medical Society of London, March 7, 1892.

(Reprinted from the *British Medical Journal,* March 12, 1892.)

SOME diseases are important on account of their severity and of the danger to life which they occasion, others are important on account of their frequency and the amount of annoyance they cause to the patient. It is only in rare cases that piles cause any danger whatever to life, but they are so exceedingly common, so very annoying to the patient, so destructive of his comfort and occasionally of his temper, that they acquire an importance which justifies me, I think, in bringing the subject of their treatment before you to-night. I shall not attempt to deal with the surgical treatment of this disease, nor can I hope to give you anything very new or very striking in regard to the medical treatment. I rather hope to bring together some simple methods of treatment, preventive and curative, and by exciting discussion on the subject to elicit other methods, some of which may be known to one and some to another practitioner, but which, I think, are not all in common use together.

I need not enter minutely into the pathology of piles, which is fully treated in works on diseases of the rectum; I may merely remind you that they consist essentially of a dilated or varicose condition of the vessels, the arteries, capillaries, and especially the veins of the rectum, which are embedded in cellular tissue of a loose and yielding character, and are covered either by the mucous membrane of the rectum, by the skin outside the anus, or partly by the mucous membrane and partly by the skin, according as they are internal, external, or intermedial (or complicated, as they are termed by Mr. Allingham). The blood from these veins returns in a twofold way into the general circulation. Part of it flows through the anastomoses of the hæmorrhoidal with the

systemic veins into the vena cava, while another portion passes up through the intestinal and portal veins. The latter portion has therefore necessarily to pass through the liver before it can reach the general circulation, and this is a point of great practical importance, because the condition of the liver seriously affects the circulation in the rectum, and an impediment to the free flow of blood through the liver may tend very considerably to the distension of the hæmorrhoidal vessels and the production of piles.

Our ideas of the liver—derived as they generally are from seeing the organ in the dissecting-room or on the *post-mortem* table—are frequently quite erroneous, for we are apt to believe it to be a hard, solid, unyielding organ, whereas, on the contrary, a sponge would more nearly represent its behaviour. If we take the liver of an animal—such as a rabbit—which has just been killed, and pass a current of defibrinated blood through it by means of cannulæ tied into the portal and hepatic veins, we find that the organ swells up enormously or becomes quite small in proportion to the pressure with which the blood is driven through it. The rapidity with which this distension and collapse occur is so great as to remind one, indeed, of the variations in the india-rubber ball of a spray producer. On looking at such an experiment, the first thing that strikes us is the question, If the liver contracts so readily under variations of blood pressure within it, why do we find the size of the liver so constant in man; why does it not expand and contract as we see it do in the laboratory? The answer to this is, I think, a very simple one. It is that the blood circulates in the portal vein under a very low pressure indeed, one which is not at all to be compared either with the pressure used in the experiment or with that which exists normally in the arterial system. But every now and again we do see the liver undergo changes in living men, quite as great though not so rapid as in the excised liver of the rabbit of which we have just been speaking. Such changes are especially common in men who suffer from malarial fever, though we see them quite as markedly in the subjects of advanced mitral disease. Such distension of the liver indicates that the blood cannot flow away through the hepatic vein so quickly as it enters the portal vein, and this condition may either be brought about by too rapid a flow in the portal vein or obstruction to the circulation either in the liver itself or in the hepatic vein and general venous circulation into which it empties itself. It is quite possible that an augmented entrance of blood into the portal system may

be one factor in producing congestion of the liver; but I think it is probable that portal congestion is generally due to obstruction in or beyond the liver. Nor do I think that obstruction to the flow of blood through the liver necessarily leads to enlargement of the liver, although it may do so. I believe—though it may be difficult to prove—that either the liver itself or the portal vein within it may present an obstacle to the passage of blood, and thus lead to portal congestion without the liver becoming any larger.

On looking at a section of the liver during fasting and digestion, one is struck by the great difference in the size of the cells in these two conditions, the cells being much larger after food. This difference must necessarily lead to a certain amount of compression both of the biliary and venous radicles, and thus hinder to a certain extent the passage of blood through the organ. The walls of the portal vein may also contract and present a certain hindrance. Whenever any portal obstruction occurs it will tend to increase the pressure in the hæmorrhoidal veins, and thus lead to their distension, notwithstanding the fact that the blood in them has another channel of exit. We can readily see that one cause of such an obstruction might be continuous enlargement of the hepatic cells from too abundant feeding, such as gave rise to congestion of the stomach in Alexis St. Martin, as observed by Dr. Beaumont through the fistula in his patient's stomach.

Another cause of portal congestion is, I think, exposure to cold, although whether this acts through the cells of the liver or through its veins I am unable to say. We notice in the case of internal piles the sphincter ani may affect them either beneficially or injuriously, according to the circumstances under which the pile is to be found. So long as the pile remains inside, the sphincter ani tends to support and thus to ease it, and will, indeed, aid the circulation of the blood within it. But if the internal pile should become protruded and grasped by the sphincter ani, the contraction of the muscle will prevent the returning of the venous blood, will increase distension in the veins, and render the pile tense and painful. A somewhat similar action to that of the sphincter ani is said by Verneuil to be exerted by the muscular fibres of the rectum upon the superior hæmorrhoidal veins. These veins pass through little openings, which have been compared to buttonholes in the muscular wall of the rectum. There are two sets of these buttonholes at right angles to each other, the first set occurring in

the circular and the second in the longitudinal fibres of the rectum. These buttonholes, like the sphincter ani in the case of the internal pile, probably have either a beneficial or an injurious action, according to circumstances, upon the hæmorrhoidal veins. It is highly probable, as Mr. Allingham has suggested, that they act as valves, tending to support the column of blood in the portal veins when there is congestion of the portal system, as, for example, in mitral disease; but it seems highly probable that they tend also, under other circumstances, to impede the return of blood from hæmorrhoidal veins by too greatly constricting them, just as the sphincter ani does with a protruding pile. Too great a constriction of these fibres would explain the occasional very rapid occurrence of piles, such as we sometimes find after a violent motion of the bowels, especially when this has been brought on by some intestinal irritant, particularly by such as seem to have a selective action on the lower bowel, like aloes. A similar excessive contraction, due to temperature, may also be the explanation of the well-known frequent occurrence of piles after sitting on a cold stone or on damp grass. It is clear that however strongly the muscular fibres of the rectum contract, they will not cause great obstruction to the return of venous blood through those buttonholes if the longitudinal and circular fibres contract with an alternate rhythm, as they ought to do, because the contraction of the one set of fibres will be accompanied by relaxation of the others, and the flow of blood through those buttonholes will be accelerated rather than hindered by the rhythmical contraction and relaxation exerting a kind of pumping action. But it is quite different if either the one or the other set of fibres should contract continuously, and such continuous contraction probably affects the circular fibres during prolonged straining at stool, when the bowel tends to be everted. Accumulation of fæcal matters in the intestine may interfere with the venous return or may act as a reflex irritant.

We may classify the causes of venous obstruction leading to piles as due (*a*) to portal congestion, and (*b*) to local irritation and contraction of muscular fibres in the rectum itself. But we have hitherto left out of account two other important factors—namely, dilatation of the hæmorrhoidal arteries and local irritation of the veins themselves; both of these probably play an important part in the causation of piles. The part taken by the arteries frequently becomes evident to the sufferer himself from the throbbing pain

felt in the bowels and coincident with the arterial pulses. Local irritation of veins has frequently the effect of causing them to dilate. When working in Ludwig's laboratory in 1869, I made a number of observations upon the effect of local irritation of arteries and veins.[1] In some of the experiments I made under Ludwig's direction the nerves of a part were all cut through, and in the arteries whose nervous supply had thus been destroyed I noticed that the arterial walls, instead of contracting as they usually do upon irritation, become dilated, and the dilatation assumed a somewhat saclike character, which lasted for a long time after the irritation had been discontinued. I observed a similar occurrence in the veins; but, if I remember aright, the veins tended frequently to become dilated on local irritation, even where the nervous supply had not been destroyed, although it is quite possible that the conditions under which the veins were observed may have partially disturbed their innervation. We cannot, therefore, throw on one side the nervous supply of the hæmorrhoidal veins as of no account in the production of hæmorrhage; on the contrary, it may have a very important action indeed, although we may not be at present able to explain it or to define its limits.

Let us turn now to the conditions which tend to bring on piles. First of all, then, we have too free living with insufficient exercise, so that the liver, which may be compared to the coal-bunker of the body, has its cells too constantly filled with reserved nutriment, and this tends to present a hindrance to the passage of portal blood. Next comes what is usually known as a chill in the liver. What the exact pathology of this is I cannot positively say, but it is a condition which comes on with very great readiness in people who have suffered much from malaria, and in them we find that the liver tends to become larger than usual—sometimes only a little, sometimes very much larger—and at the same time becomes tender to touch. This condition is frequently associated with loss of appetite, and sometimes with intestinal pains, and a frequent concomitant of it is piles. This condition is brought on in persons subject to malaria with very great ease indeed, and the observations made upon them are most instructive, as showing us how to treat not only such patients, but also others who may suffer from the same causes in a less degree. There are four places in such persons which are apt to be affected by a chill.

[1] *Ludwig's Arbeiten*, Vierter Jahrgang, p. 107, and *Ber. d. K. K. Gesellsch. d. Wiss.*, Bd. xxi, p. 291.

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First, the back of the neck; secondly, the abdomen; thirdly, the shins; and fourthly, the feet. The danger of wet feet is universally recognised, and no one wonders when a person gets gastric or intestinal catarrh, or both together, after sitting in wet boots. The danger of cold to the abdomen is almost universally recognised in tropical countries, and in India people will wear many turns of cloth round their middle who have little covering to the rest of their bodies.

The danger of chill to the back of the neck is less recognised, but while a cold wind blowing in the face may be braved with impunity, I have seen a cold draught on the back of the neck bring on a fit of ague in a little more than five minutes. The risk of a chill to the shins is still less known, but is very important, and perhaps the cause of more unsuspected disturbance of the liver than all the others put together. While the body and feet are warmly clad, people frequently go about wearing short socks and thin merino or silk drawers, which form a very imperfect protection from the cold air which passes up under the trousers. Thus it is that in travelling the legs frequently become chilled; but a chill is got more often still by the person sitting between the door and fire-place. As the fire burns briskly in an open grate, the heated air passes in a rapid current up the chimney, and its place must be supplied by fresh air from outside the room. It is quite unusual to find a Tobin's tube or other ventilating apparatus in a room, and consequently the air must come either through crevices in the window or the door. In a well-built house the windows fit tightly; the door also fits tightly into its frame on both sides and the top, but underneath there is usually at least half an inch between the door and the floor, so that it may not rub against the carpet. Underneath the door the cold air comes, and if the fire is burning briskly there is a strong draught which may be felt by any one who puts the hand to the foot of the door. This cold draught diffuses itself along the floor on its way to the fire-place, and if any one sits in it his feet and legs are apt to become chilled. He may not be aware of the reason, for neither he nor any one else may be able to feel a draught at the place where he is sitting, because even when a draught is quite strong at the doorway itself, it becomes too weak to be felt by the hand held close to the floor across the room for a few minutes. Yet it may be quite sufficient to chill the limbs of any one sitting in it for half-an-hour or longer.

The next cause of piles is local congestion of the rectum by straining at stool. This must be carefully avoided, and the patients instructed not to remain long in the closet. There is frequently a tendency to do this when there are piles, even when the bowels move freely, because the piles themselves give a sensation to the patient of something in the rectum, and he strains to get rid of what he believes to be the fæces. The more he strains the worse he gets, until the piles come outside, and then he may think that the bowels are empty. In cases where the motions are very constipated, an aperient pill, liquorice powder, cascara, or other simple laxative may be employed to keep the bowels open; or glycerine enemata or suppositories, or an injection of simple water or oil may be used.

And here I think it is worth while to give a warning against the water-closet as a place where there is a great risk of another sort, and which, indeed, may lead to fatal consequences. As a rule the water-closet is destitute of every means of warming it, and people who would never dream of going out of the house into the open air without warm clothing, will sit in the closet, which is quite as cold as the external air, not only without any extra covering, but with a considerable portion of their body exposed, and will sometimes remain there for as much as ten minutes, and in some cases even more. They thus run a great risk not only of chill to their abdomen, which may lead to portal congestion and piles, but even of getting a chill which may result in pleurisy or pneumonia. This danger is one which ought to be avoided in cases of convalescence in acute disease, such as influenza. I have been astonished to find so many patients completely neglect what appears to be such a natural precaution. In such cases the patient ought to be obliged to use a commode in his bedroom, or the closet should be warmed by a large paraffin lamp or stove.

Local congestion by excessive straining may be due, not to constipation, but to diarrhœa. The intestinal condition which gives rise to this may be due to acrid substances, which not only irritate the upper part of the bowel and give rise to increased peristalsis, but they may have upon the rectum a double action, namely, (1) an irritant one on the mucous membrane giving rise to straining and sometimes to a feeling of burning; (2) an irritant action upon the veins and arteries tending to cause dilatation and varicosity. Another condition of the fæces which may give rise to local irritation is a pulpy sticky condition so that they are with difficulty

removed. This condition leads to increased rubbing of the anus with paper in order to cleanse; and if small external piles be already present, the difficulty of cleansing is rendered greater because the fæcal matters tend to rest in the crevices between the piles, and so are removed with difficulty. If printed paper from which the ink comes off be used, the irritation appears to be greater, and the mere continued use of such paper may tend to cause piles even in persons who might otherwise be free from them.

Local congestion of the rectum is increased or brought on by sedentary occupations; for in these not only does want of exercise retard the flow of blood, but the local warmth tends to cause distension of the hæmorrhoidal vessels and bring on piles. When persons have to sit much they ought either to use a hard wooden chair or a cane-bottomed chair. If by chance the chairs with which they are provided in the offices they hold are soft and stuffed, they may use a circular cushion with a hole in the middle, so as to give a certain amount of ventilation and coolness to the neighbourhood of the anus itself. Such cushions also relieve pressure on piles already present.

There is still another factor to be borne in mind in the causation of piles, and that is the general condition of the patient as affecting the state of his vessels. Gouty people are particularly prone to phlebitis, and in them we find inflammation of the veins of the legs occurring now and again without any apparent reason. But we know as a matter of experience that a glass or two of champagne tends to exacerbate gouty symptoms as a rule, and in some people a glass or two of champagne may bring on an attack of piles. Of course it is possible that the wine here acts partly through the liver by obstructing the circulation in it in the way already discussed, but it seems highly probable that it has another action as well upon the hæmorrhoidal vessels themselves.

Turning, now, to the treatment of piles, we may consider, first, how we are to keep the liver in such a condition as to maintain a free supply of blood through it. For this purpose, we should insist on moderation in cases where we have reason to believe that either the food or the stimulants taken are in excess of the wants of the organism. The occasional administration of small doses of a mercurial purgative, followed by a mild saline, tends to keep the liver free and to prevent piles, although one may not know the exact *modus operandi* of the mercury upon the liver. Of

course the saline ought not to be too violent, or it will tend to cause local congestion and make matters worse. Aloes bears an evil repute on account of its irritant action upon piles, but its effect depends upon the quantity given; and while a large dose of an aloetic pill will almost of a certainty produce rectal irritation, small doses such as $\frac{1}{10}$ grain of aloin three times a day with each meal, will tend to lessen piles by keeping up a gentle peristaltic action and preventing constipation. My friend, Mr. Archer, tells me that he has used with invariable success half an ounce of castor-oil given to begin with, and followed up by half a drachm every morning for a month.

I have already discussed the prevention of portal congestion from chills, but when it has occurred a useful application is a hot-water india-rubber bag, with a plush or flannel covering, put under the back of the neck, and a similar one over the liver. This tends to restore the equilibrium of the circulation and lessen portal congestion.

Exercise is useful in keeping the liver free, but this exercise must be of a certain kind. As I have already said, the liver is a very spongy organ, the blood pressure within it is very low, and the pressure under which bile is secreted is also very low. Both blood and bile, therefore, tend to stagnate within it, but this stagnation is lessened by the liver being rhythmically squeezed, more or less forcibly, between the diaphragm and abdominal muscles. In a person standing or sitting upright, or lying on either side, this squeezing action is very slight; in a supine posture it is slightly greater. In ordinary walking it is also very slight, but in walking up a hill, and especially in climbing a mountain, the amount of pressure to which the liver is subject is considerable, because the muscles of the abdomen in such exercise are actively contracting, and the movements of the diaphragm during the panting breathing which occurs on exertion are much greater than when a person is quiet. A similar process of squeezing occurs in brisk horse exercise, either trotting or cantering, and thus riding is frequently beneficial for piles, notwithstanding the increased local irritation from contact with the saddle. Another useful exercise is to touch the toes with the fingers, keeping the knees straight, several times every morning.

A regular action of the bowels is of the utmost importance in preventing piles, because it tends not only to keep the circulation through the liver free, but prevents straining. The different

means of ensuring this regularity of action would require a paper to themselves, but a teaspoonful of compound liquorice powder at night, or confection of senna either alone or with confection of sulphur and confection of pepper, are perhaps amongst the most widely employed of all the laxatives. No doubt the best times ordinarily for emptying the bowels is after breakfast, but if the piles tend to come down much it is better for the patient to get into the way of emptying the bowels every night before going to bed, so that he may secure rest in a recumbent position for several hours. Some patients in whom the piles come down easily spend a day of misery if they are obliged to go to the closet in the morning instead of the evening, because the piles tend to remain down all day and worry them.

The soft unprinted papers which are now commonly sold are a very great improvement upon the ordinary newspapers, but even they sometimes give rise to a good deal of irritation. In cases where the piles are very troublesome it is always well for the patient to wash the anus immediately after a motion. It is sometimes impossible for the patient to go from the closet to his bedroom and wash there, and I have found the easiest way of getting over this difficulty is for him to carry with him to the closet a soft sponge in a small india-rubber bag; an ordinary tobacco-pouch is best. If it should be an earth closet, the patient should take the sponge full of water, and, after cleansing the anus gently with paper, he may thoroughly sponge, and then return the sponge to the bag. The anus may then be dried either with the porous paper, or with a small napkin which he carries with him. In the case of a water-closet the sponge may be taken dry, and after the closet has been used the plug may be drawn and the sponge dipped in the clean water which then fills the pan, and used in the way I have just mentioned. The patient should also take with him to the closet a small bottle of some preparation of hamamelis and some prepared wool. This should be sheep's wool deprived of its fat, and not cotton wool. The wool thus prepared is quite absorbent, and takes up the hamamelis readily. It differs from the cotton wool in one important particular, for it forms a kind of felt, which the cotton does not. A small pledget of the wool about the size of a hazel nut should be dipped in the hamamelis and introduced within the anus, and a similar pledget, likewise soaked in the hamamelis, should be introduced so far within the anus that a few fibres of it at least are caught by the sphincter. The external

pledget soon becomes felted together into a regular pad, fitting completely to the anus, and being retained by the few fibres caught by the sphincter it will remain there for twenty hours, while a similar pad of cotton wool might not remain as many minutes. This wool pad not only keeps the hamamelis in constant contact with the piles, but also affords a certain amount of mechanical support. In patients suffering from piles we frequently notice an almost involuntary tendency to sit on the corner of a table or on the arm of a chair, or to put the hand behind and press upon the anus from time to time; but the woollen pad, by affording a constant support, tends to lessen the necessity for pressure in any of these ways. Where the piles are chiefly internal the hamamelis may be applied in the dose of half-a-drachm to a drachm, either diluted with water, or, as is sometimes preferable, undiluted, by injecting it within the anus by means of a glycerine syringe. The success of this treatment in stopping hæmorrhage from piles is really extraordinary; within a week I have stopped the hæmorrhage from piles which were bleeding so profusely that a colleague thought that an operation would be necessary. But not only does the hamamelis stop hæmorrhage, it lessens the uncomfortable weight and aching pain which so frequently accompany piles, especially when they do not bleed; and it will even greatly lessen or remove the pain which occurs in piles when they become inflamed. I have tried various preparations of hamamelis, but I have not found either the tincture or the local extract, both of which are to be found among the recent additions to the *Pharmacopœia*, nearly so satisfactory as some of the proprietary preparations.

The patient requires to be carefully instructed in the mode of using it, otherwise disappointment may ensue. Some time ago a lady who was passing through London on her way to the Continent was seized with a sharp attack of piles. I was asked to see her at an hotel, but, not being able to go for a couple of hours, I hastily wrote down a prescription for hamamelis and gave it to the maid, with, as I thought, definite instructions how to apply it. On going to the lady two hours afterwards, I found that she had used the whole bottle, but with no relief whatever; nor was this to be wondered at, for the piles were internal, and the hamamelis had only been used externally. Lanolin takes up a considerable quantity of hamamelis, and a combination of the two forms a most satisfactory ointment.

In obstinate cases of piles, great relief is afforded by the anal

pad. The simplest is one of india-rubber with elastic straps to hold it in place, but it does not give, I think, quite the same relief as one in which the pad is pressed against the anus by a spring attached to a metal girdle which passes round the loins.

Before concluding this paper, I may mention another affection which frequently goes along with piles, and is most annoying, namely, pruritus and eczema round the anus. Both of these affections may be lessened by a simple remedy—eau-de-cologne applied to the itching surface with a small sponge or pad of cotton wool. If the skin be at all tender, undiluted eau-de-cologne gives rise to intense burning pain, but this may be prevented by diluting the spirit before application. The diluted spirit does not have such a strong and permanent action in lessening the itching as the pure spirit, and where the itching is at all great, the pure spirit may be used, notwithstanding the pain it causes, for it converts the intolerable itching into a severe smart, and this may be relieved by diligently fanning the part till the spirit evaporates.

I have not attempted to discuss all the methods of treatment; I have rather brought forward some which I have found practically exceedingly useful, and which are, I think, at least in their details, not so widely known as they deserve. I am quite conscious how trivial they are, but the number of cases in which piles occur give an importance to any useful method of treatment, however trivial it may be in itself, and this must be my excuse for bringing the subject before the Society.

CASE OF INTESTINAL OBSTRUCTION DUE TO NARROWING OF THE CALIBRE OF THE BOWEL, AS THE RESULT OF RECURRING APPENDICITIS.

IN CONJUNCTION WITH W. WATSON CHEYNE, F.R.C.S., F.R.S.

Read April 27, 1894.

(Reprinted, with kind consent of Mr. Cheyne, from vol. xxvii. of the *Clinical Society's Transactions.*)

THE patient was a gentleman æt. 35, who was first taken ill in May 1892, with fever, pain in the right iliac fossa, and other symptoms which led to the diagnosis of appendicitis, but which subsided without surgical interference. Since that time he had had a number of similar attacks of varying intensity, five of them severe ones, the last one being in May 1893, and lasting about fourteen days. He had during this time paid great attention to the regulation of his diet, living chiefly on soups, potted meat, bread and milk, etc. He had been seen at various times by Dr. Lauder Brunton and also by a well-known surgeon, who had urged removal of the appendix, to which the patient would have submitted but that he did not feel able to spare the necessary time from his work. During last summer the patient remained pretty well, except that he was much troubled with obstinate constipation. On September 11 last he had a severe attack of griping pain, chiefly on the left side, which lasted nearly an hour and then passed off.

These attacks continued to recur with increasing frequency, and the constipation, though not absolute, became more obstinate. He had no fever, and did not remain in bed. On the evening of September 22 he took a dose of castor oil, which did not act; on the contrary, the griping pains became very severe and almost constant, and he was completely obstructed, no flatus being passed. He had no vomiting. During the afternoon of September 23 he passed into a very collapsed state, the pain became intense, and Dr. Brunton was sent for. He advised that a surgeon should be

called in without delay, and accordingly Mr. Watson Cheyne was asked to see him, and did so with Dr. Brunton at 10 p.m. His condition was then as follows:—Pulse 80, very small—in fact, hardly perceptible. Temp. 97·4°. Great pain, essentially of a griping character, starting on the left side and running towards the umbilicus; no tenderness anywhere, not much distension, and what there was, was of a uniform character; no dulness. Tongue moist and not furred. He vomited while we were there, the vomited matter evidently being stomach-contents, and Mr. Cheyne understood at the time that this was the first occasion on which he had vomited. While writing out the case, however, the patient tells us that he had vomited once if not twice before we arrived, and he thinks the vomit was stercoraceous, but what he vomited while we were there was not so.

Careful consideration of the history of the case, and of the existing condition, led us to the conclusion that the bowel at some part had become much narrowed as the result of the previous inflammatory attacks, and that the castor oil had caused increased congestion of the mucous membrane and completed the obstruction. We decided to leave him alone for the night, and ordered opium and atropine subcutaneously and fomentations, in the hope that the obstruction might yield : $\frac{1}{60}$ of a grain of strychnine was also given every four hours.

September 24, 10 a.m.—Patient has passed a very bad night, and has had no sleep. Since 7 a.m. the pain has been constant and severe, and he has vomited stercoraceous material on three occasions. Temp. 97°. Pulse cannot be felt: patient wandering and evidently moribund. When placed upon the operating table the patient was so far gone that we several times thought him dead, as he became insensible, the lower jaw fell, the half-closed eyes seemed to be glazed, and the surface was cold. It was only with a great deal of trouble that a feeble pulsation could be detected at all at the wrist, and the respirations were so faint that they could sometimes only be detected by minute inspection. As soon as possible afterwards the abdomen was opened in the middle line, and the small intestine was seen to be much congested and full of fluid and gas. On searching the abdomen with the finger, thickening was felt in the right iliac region. A second incision was therefore made inside the anterior superior spine, and the region of the ileocæcal valve was at once exposed. The intestine at this part was thickly covered with adhesions,

chiefly old and tough, but some apparently more recent. Embedded in this mass lay the appendix, which was coiled upwards and partly round the ileum, and contained a concretion. The appendix had evidently been in this position for a long time. It was freed and removed, and then the mass of adhesions was cut and torn through till it was found that the contents of the small intestine could be readily passed on into the cæcum. A drainage-tube was passed down to this part, and the rest of the wounds stitched up. After the operation, which lasted nearly three-quarters of an hour, and during which ether had been administered, the pulse was perceptible; ether and strychnine were administered subcutaneously.

At 4 p.m. we found the patient easier, pain less, no further vomiting, pulse rather better, 90; temp. 97·2°; tongue brown and dry. No gas or fæces had been passed. Six ounces of urine were drawn off (all that had been secreted since the previous afternoon).

At 10 p.m. pulse worse, barely perceptible; no vomiting. Ordered brandy *per rectum*, and repeated injections of strychnine and ether. A quarter-grain of morphia was given subcutaneously.

September 25, 8.30 a.m.—Patient has passed a restless night; no vomiting, pain less; no distension, no gas or fæces passed; pulse as bad as ever, 120; temp. 97°. Ordered nutrient enemata, a little whisky, and Valentine's meat juice by the mouth, and to continue the strychnine.

9 p.m.—During the afternoon patient had two copious and extremely offensive motions, after which he was much exhausted. Pulse very much better, 100; temp. 99°.

September 26, 8.30 a.m.—Has passed a much better night; pulse good, 100; temp. 99°. Three fluid motions during the night. Ordered feeding by the mouth, and salol 10 grs. t. d. s.

Further reference to the daily progress of the case is unnecessary, as from this time the improvement, as regards the action of the bowels and the general condition of the patient, was practically uninterrupted. On September 30 the stools were solid for the first time. As regards the progress of the wound healing occurred satisfactorily except along one stitch track in the central incision, where a small abscess formed, no doubt because the skin was imperfectly disinfected in the haste with which the operation had to be done; this, however, gave no trouble. The drainage-tube leading down to the appendix was left out after ten days, the wounds were healed, the dressings left off on October 13, and the

patient was up and dressed on October 20, and went out for a walk three days later.

Since that time the patient has remained well, and he writes a few days ago (beginning of February 1894) as follows :—"As regards my present condition, I may say that every one who knows me says that I have not looked so well for years. I have been out to several dances and dinners, and can eat and enjoy everything that is put before me. The bowels are acting regularly." The scars of the incisions are quite satisfactory, except at the place where the drainage-tube was, where there is a slight tendency to bulging, on account of which he is wearing a belt. (April 1894.—Patient remains well.)

This case seemed to us of sufficient interest to be placed on record for three reasons: firstly, from the point of view of diagnosis; secondly, from the success attending the separation of the adhesions; and, thirdly, from the extreme depression of the heart's action, a depression out of proportion to the other symptoms.

As regards the diagnosis, the first question that presented itself was—was this an attack of appendicitis, as the others had evidently been? or was it some sequela of the former attacks? The presence of a fresh attack of appendicitis was negatived chiefly by the history, by the absence of tenderness and fever, and by the character of the pain, which was spasmodic, griping, and referred especially to the left side and the umbilicus. The great difficulty was in excluding strangulation by a band. Our reasons for doing so were the history of increasing difficulty in getting the bowels to act during the summer; the long duration of the present symptoms (eleven days); the character of the symptoms during that time, viz. the intermittent attacks of griping pain; the good general condition in the interval between the attacks, the patient being able to go about; the fact that the obstruction was not complete till within twenty-four hours of the time that we saw him together, and the absence of vomiting. (I have already mentioned that the patient has lately corrected this last statement, but Mr. Cheyne did not so understand at the time, and the absence of vomiting was one of his chief reasons for allowing a few hours more to elapse before operating.) These facts all pointed to a narrowing of the calibre of the bowel, and the coincidence of the complete obstruction with the dose of castor oil added to the certainty of the diagnosis, as indicating the existence of a narrow channel which had become closed as the result of inflammatory swelling of the mucous mem-

brane, increased by the action of the oil. It was this diagnosis which seemed to us to warrant a few hours' longer delay, although the patient was in a very critical condition. We could not tell that the adhesions around the gut were so limited in extent and could be so easily disposed of as they proved to be; on the contrary, it seemed not improbable, considering the frequent attacks and the length of time that the trouble had been going on, that we should find a more extensive matting together of coils of the intestine, a condition which proved in one case, where Mr. Cheyne attempted to separate the adhesions, to be practically irremediable except by intestinal anastomosis. It therefore seemed to us right to allow a few hours longer to elapse, in the hope that with opium and fomentations this swelling of the mucous membrane might subside and allow passage of the fluid onwards, and a laparotomy under more favourable conditions.

As regards the operation itself, the ease with which the constricting bands were got rid of, and the apparently permanent expansion of the intestine which has resulted, are matters of great interest and importance. As a rule, the matting in cases of narrowing of the bowel after peritonitis is more extensive; it is very difficult to separate the adhesions without damaging the bowel, and fresh adhesions tend to form afterwards. As regards the incisions, the opening was made in the middle line in the first instance, because the patient localised the pain on the left side of the umbilicus, and it was thought well to ascertain the condition of the abdomen with the finger before cutting down on the appendix.

The third point of interest is the extreme depression of the circulation, which lasted so long after the operation, and passed off shortly after the free evacuation of the bowels. The explanation seems clearly to be that the intestinal contents were highly toxic, and that poisons were absorbed into the circulation which produced this marked depression; in fact, the patient was suffering from septic intoxication. Various substances have been obtained from putrefying material which have this depressing effect. It has been maintained by several surgeons that some of the bad symptoms in strangulated hernia, and especially the failure in recovery after operation, are in some cases to be explained by absorption of putrid matter from the intestine. In the case of strangulation, however, there is also a large amount of shock, and it is not easy to say how much of the trouble is due to shock, and how much, if any, to

septic intoxication. But in this case there was no strangulation in the proper sense of that term, and no shock from that cause, and it is difficult to find any other satisfactory explanation of the patient's condition than that it was due to sapræmia from absorption of poisons from the intestinal canal, and it seems to bring strong evidence in favour of the view alluded to with regard to strangulated hernia. Indeed, it became a question whether the depression still continued after the operation, whether one should not make an attempt to remove this poisonous fluid by tapping the ileum through the wound.

In conclusion we would refer to the great value of strychnine in these cases, and it is doubtful whether this patient would have recovered but for its administration during the critical period.

A CASE OF PERFORATING TYPHOID ULCER TREATED BY OPERATION AND SUTURE, AND RESULTING IN RECOVERY.

IN CONJUNCTION WITH ANTHONY BOWLBY, F.R.C.S.

Paper read before the Royal Medical and Chirurgical Society of London.

(Reprinted, with kind consent of Mr. Bowlby, from vol. lxxx. of the *Medical Chirurgical Transactions.*)

Received May 4th, 1896—Read January 26th, 1897.

JOHN DUGGIN, aged 37, was admitted into "Rahere" Ward, St. Bartholomew's Hospital, under Dr. Lauder Brunton, on October 3, 1895. He was then suffering from diarrhœa. In the beginning of September he had a cough and pain in the chest. On September 20 these symptoms got worse, and the patient had a headache. There was no shivering or vomiting. On the 26th was obliged to go to bed. On this day he vomited. The coughing continued. On September 28 the bowels were open two or three times a day, and diarrhœa continued till admission.

On admission he seemed semi-comatose, with a temperature of 103·4°, pale face, and dry, brown, cracked tongue. The abdomen was moderately distended. The liver and spleen were not felt, but were apparently very tender. The bowels were open four times. The motions were light yellow, free from blood. There was gurgling in the right iliac fossa. The respirations were 28; loose cough; no expectoration; no dulness but rhonchus over the whole chest. The cardiac sounds were apparently free from any murmur. The case was diagnosed as one of typhoid fever. On the day after admission he passed two or three ounces of bright blood. The bronchitis continued, and on the 15th there was some bronchial breathing at the right base, which appeared to be due to collapse. The temperature was very irregular. On October 24 it was nearly normal, and continued so until the 30th, when it again rose. Typhoid spots came out and the spleen was tender. The temperature fell again on November 12, and remained subnormal

until December 7, when it rose to 99·8° in the evening. On the 8th it was 100·2°. On the 9th it was 99·4°. Each day the temperature fell in the morning nearly to 98°. The next three days it never rose above 99°. The lungs were clear, the spleen could not be felt, although there was some tenderness in the splenic region, and there were no spots.

On the morning of December 14, at 3 a.m., the patient woke up complaining of very severe pain in the abdomen. He complained of feeling cold, and his temperature sank to 97°. After the application of a large poultice the pain became easier, and he went to sleep. On awakening he still complained of bad griping pain, and about 8 a.m. the bowels were opened and a natural motion passed with some relief. At 12.45 p.m. he was seen by the house physician. He was then complaining of severe abdominal pain, which was worse in the epigastrium. The temperature was now 102°; pulse 110, soft. There was slight distension of the abdomen below the umbilicus, but the upper part moved well on respiration. He was very tender to deep palpation, and on deep inspiration or coughing. The liver dulness was normal. The patient lay on his side with his legs drawn up, but he could lie straight on his back without pain. He had not been sick or complained of nausea, and he had taken liquid food without trouble. At 3 p.m. he was seen by Dr. Brunton, who considered that an operation might be required later on, and asked Mr. Bowlby to see the patient at 5 p.m. There was not then much change in his condition except that he was rather more easy. There was still no sickness. At 8.30 p.m. he was again seen by Dr. Lauder Brunton. The general condition was still good, and there was no sickness, but the distension of the lower part of the abdomen had increased, and abdominal respiration was much more limited. Flatus was retained, and the liver dulness was still natural. It was considered that the symptoms were probably due to perforation of the intestine at the seat of an ulcer, but it was evident that if this was the case there were adhesions limiting the escape of the contents of the bowel to the lower part of the peritoneal cavity. As the symptoms were ingravescent Dr. Brunton decided that laparotomy ought to be done without further delay, and the operation was accordingly performed as soon as possible after this by Mr. Bowlby. Mr. H. Marshall acted as assistant during the operation.

The patient was placed under the influence of chloroform, and the abdomen was opened in the middle line below the umbilicus.

The upper part of the peritoneal cavity was free from gas or fæcal matter, but the great omentum was adherent in the pelvis, and as soon as it was separated from the subjacent intestine it was found that the whole of the intestines beneath it were matted together. On freeing the uppermost coils about half a pint of fluid was set free. It was dirty yellow in colour, and evidently consisted of some intestinal contents mingled with peritoneal exudation. On passing the hand into the cavity amongst the intestines from which this fluid had escaped, a very indurated coil of bowel could be felt, and after a little trouble was separated from its adhesions and drawn out of the abdomen. It was then seen that the gut had been perforated by a small ulcer, about as large as a pea, situated opposite to the attachment of the mesentery. This ulcer was evidently in the centre of an inflamed Peyer's patch, for an area of induration corresponding in size to such a patch could be felt in the wall of the bowel. The whole coil of intestine was covered with fibrin and recent lymph, and was thickened and œdematous. This lymph was removed as thoroughly as possible, and the whole bowel very carefully washed. Ten silk sutures were then passed after Lembert's method, transversely to the long axis of the bowel, which was clamped by the fingers of the assistant. The sutures furthest from the ulcer were passed clear of the indurated Peyer's patch, so that the line of suture was about an inch and a half in length. Flatus and fluid matter were then allowed to enter the sutured coil of gut, and it was found that there was no leakage, and that the lumen was free. The abdomen was finally irrigated with hot water until all foreign matter seemed to be quite removed, and a drainage-tube having been passed into the pelvis, the wound was sutured. The operation lasted about forty minutes, and the patient was not at all collapsed at its conclusion.

Recovery was uninterrupted, the temperature remaining normal throughout. The tube was removed in forty-eight hours, and for four days no food was given by the mouth, except water in tea-spoonful doses. The bowels acted on the fifth day, after the use of an enema, and for the next month the patient was very carefully dieted. He left the hospital on February 21 in good health, and returned to his work in April. When seen on April 15 he had regained his normal weight, and the bowels acted regularly. For several weeks after operation he had a slight "dragging pain" in the abdomen and a feeling of tightness, but this gradually passed away.

There is but little to be said with regard to the operation itself. It was performed with the precautions which are customary in all cases of abdominal section for peritoneal inflammations, and the only point besides the method of suture which requires comment is the cleansing of the affected intestine from adherent lymph. As has been already mentioned, there was a considerable quantity of this material present, and it was attached more firmly to the bowel than is common in cases of perforation. It was rubbed off with sponges until the peritoneal coat was quite clean, for it was felt that in the meshes of the lymph there must necessarily remain some of the septic material in which it had been soaked, and no amount of mere irrigation could have detached it. It seems probable that the uninterrupted recovery after the operation may be in part due to the complete removal in this way of a possible source of septic inflammation.

With regard to the actual treatment of the perforation and the passage of the sutures, it was found that there were two difficulties to be overcome. The first of these was the friability of the recently inflamed intestine, and the second the induration of the affected Peyer's patch and the consequent obstruction offered to the inversion of the bowel and the approximation of the peritoneal coats. To overcome these difficulties it was found necessary to pass the sutures at some distance from the perforation, and to draw the peritoneum from the lateral aspects of the bowel over both the puncture and the indurated Peyer's patch, for the latter remained like a rigid body in the substance of the intestinal wall, and quite prevented any doubling in of that part where the perforation itself was situated. In consequence, however, of this method of suture the lumen of the bowel at the site of operation was materially diminished, and it was evident that some permanent narrowing would probably result. It did not, however, appear likely that the narrowing would be sufficient to cause serious stricture, and it is to be noticed that now a year after operation the bowels act regularly, and there is no evidence that the calibre of the intestine is obstructed.

It is nevertheless certain that these difficulties in suturing are liable to be met with again in other and similar cases, and it is quite probable that in some of them this friability of the intestine and the rigidity of the subjacent Peyer's patch may make suture impossible. But, whilst it is evidently premature to come to any decision as to the best method to adopt under these circumstances,

it may be pointed out that the peritoneal cavity could be shut off quite safely from the intestinal lumen in such a case by the suture of the bowel around the perforation to the parietal peritoneum, and the consequent formation of a fæcal fistula, which might be left to heal or might require a subsequent operation for its closure.

Another alternative might be preferred, namely, the resection of the affected area of bowel, and this resection might be limited to that part of the bowel containing the affected Peyer's patch, or might be extended so as to comprise the whole coil of intestine. It is not likely that either of these latter procedures would be frequently adopted, for the condition of the patient would, as a rule, demand that the operation should not be prolonged, and there seems but little objection to suturing the bowel to the parietes, and leaving the perforation open, for this could be done with but very little loss of time and without material difficulty.

In conclusion we may point out that the case was one unusually well adapted for operative treatment, and cannot be compared with those cases where perforation occurs during the height of the fever, and in a patient greatly prostrated by the disease. It is probable that the aperture in the bowel had really existed for some time, and had been temporarily but insecurely closed by adhesions. These had yielded when a fuller diet was allowed, and had permitted an escape of the contents of the intestine.

The diagnosis of this case was tolerably clear, but the absence of any vomiting or nausea, the natural action of the bowels some time after the pain came on, and the absence of any evidence of free gas in the peritoneum combined to create some doubt when the patient was first seen. It was evident after a short time that there was commencing peritonitis in the lower part of the abdomen, and although it is true that this may occur as a complication of typhoid apart from perforation, the history of the case rendered the presence of a perforation more than probable. Whether such cases can recover if left alone is a question which has been frequently debated, but it is now generally conceded that recovery after perforation is of extreme rarity, and not to be anticipated in any given case.

We do not propose to criticise in detail the experiences of other practitioners, but it may be pointed out that there appear to have been up to the present three successful cases of operation on perforated typhoid ulcers. A review of all recorded cases by Dr. Robert Abbe appeared in the *New York Medical Record* for

January 5, 1895, and from this it appears that the successful operators have been Van Hook (*Philadelphia Medical News*, vol. ix. p. 591), Abbe (*loc. cit.*), and Netschajew (*St. Petersburg med. Woch.*, 1894, No. 36, Supplement No. 8, p. 46). The last surgeon resected the affected portion of bowel and sutured the divided ends.

Two operations have been recorded in England, by Bland Sutton and Allingham, but in each case the patient's condition was evidently very bad, and the results were not satisfactory. It would appear that the case here described is the third recorded case of the kind submitted to operation in this country, and the first to arrive at a satisfactory termination.

(For report of the discussion on this paper, see *Proceedings of the Royal Medical and Chirurgical Society*, Third Series, vol. ix. p. 42.)

ON THE USE OF BROMIDE OF POTASSIUM AND SALICYLATE OF SODIUM IN HEADACHE.

(Reprinted from the *Practitioner*, February 1894.)

In a paper published in the *St. Bartholomew's Hospital Reports*, in 1883, I mentioned the use of salicylate of sodium in relieving headache.[1] The formula that I then recommended was two and a half grains of the salicylate of sodium, given either alone or with some aromatic spirits of ammonia, every half-hour while the headache lasts. In some cases this form of administration is no doubt useful, but since the paper in which I recommended it appeared, antipyrin has nearly displaced the salicylate as a means of cutting short a headache which has already begun. One great difficulty which is to be met with in treating nervous headaches, or so-called bilious headaches, is that once the headache has become severe both secretion and absorption from the stomach are generally arrested, and that any medicine which is taken by the mouth when the headache is fairly begun lies in the stomach unabsorbed and useless. Consequently it is sometimes almost imperative to treat such cases, when the headache is intense, by the subcutaneous injection of morphine. It may not unfrequently be noticed that if the headache comes on shortly after food has been taken, for example an hour or half-an-hour after breakfast, the secretion will have occurred before the pain has commenced, and the gastric juices will dissolve the food. But the food will not be absorbed and will be brought up in full quantity, but well digested, many hours afterwards, say in the evening. Should the headache however have become well established before breakfast, and food be taken notwithstanding the pain, the secretion of gastric juice is frequently arrested, so that the food will be brought up at night almost unchanged, neither digested nor absorbed. In consequence of this arrest of absorption in many cases of headache, medicine administered by the mouth

[1] 'Disorders of Digestion,' p. 98.

after the pain has become severe is of little or no use. It simply remains unabsorbed in the stomach. It is on this account that patients are often disappointed in the action of such a drug as antipyrin, and will look upon it as uncertain because at one time it has acted like magic and at another time it has had no effect whatever. If taken before the absorption has ceased, so that it has become absorbed, it is very likely to act like a charm upon the headache; but if taken when the pain has become severe and the absorption has become arrested, it lies in the stomach and remains useless. In some cases where the headache is intense and absorption from the stomach has ceased, almost the only way of relieving pain is by the subcutaneous injection of morphine. This, however, is a method which one only employs when everything else fails, because of the risk which it entails of establishing the morphine habit.

To the treatment of this class of cases I will return afterwards, but I wish first to say a few words about the causation of headache.

In my former paper I mentioned that in treating a case of headache the first thing to do was to see if the teeth were sound and the eyes normal, and that next the throat, ears, nose, and scalp should be examined in order to detect any source of local irritation. In estimating the effect of different conditions in causing headache, I should say roughly that between 80 and 90 per cent. of all headaches are due to visual defects, about 10 per cent. to decayed teeth, and somewhere about 5 per cent. to disorders of the nose, throat, and other causes. The commonest defects of vision are uncorrected hypermetropia, myopia, astigmatism, inequality of the focal distance of the two eyes, and imperfect convergent power. This last is one not generally considered, but in the case of a student at St. Bartholomew's, who was unable to read for his examination at the London University, all other defects had been corrected, and still the headache remained, until my colleague Mr. Jessop corrected his convergence by means of wedge-shaped glasses, when the headache at once disappeared.

In cases of migraine associated with inequality of visual power in the two eyes, the headache is apt to affect the side of the weaker one. In one interesting case of a lady who suffered from migraine, the headache sometimes came on one side and sometimes on the other. I found that on the one side there was a weak eye and on the other there was a decayed tooth. In another case a lady had

been suffering from headaches for nearly thirty years, and looked upon them as a dispensation of Providence, which she considered it not quite right to meddle with. However, her brother, an old fellow-student of mine, pressed her to come and see me. I gave her no medicine, but sent her to one of my colleagues, who provided her with a proper pair of spectacles, and in three months the dispensation of Providence had almost completely disappeared. Another curious case was that of a lady-principal of a large ladies' college in the United States, who had been recommended to me by my friend Dr. Putnam of Boston. For two years she had been unable to perform her duties on account of severe pain at the back of the neck, about two and a half inches below and one inch to the right of the occipital protuberance. I thought that she had got some injury to the vertebræ, and my treatment being all in vain I asked my friend Dr. Ferrier to see her. He also was inclined to think that there was something wrong with the cervical vertebræ, but we could not come to a definite diagnosis. She went to Germany, and was treated there also for her headaches, but all in vain. On her way back to America she came to see me to say good-bye, and then incidentally mentioned that a cousin of hers had suffered in a somewhat similar way and had been greatly benefited by an oculist. At once the truth flashed upon me, and I sent her to get her eyes carefully measured. She had just time to get spectacles before the steamer started. Two or three months later I heard from her that her headaches had nearly disappeared, so that she was able to resume with comfort her position as principal of the college.

Headache due to visual defect is usually frontal, temporal, or occipital. Had the pain in this lady's case been a few inches higher up I should at once have suspected the eyes as its cause; but it was so low down in the neck that I never thought of connecting it with visual defect.

The first point, therefore, in the treatment of cases of headache is to ascertain whether there is any deficiency in the sight, and if so to have it corrected. It is astonishing to find how many people's vision is abnormal without their being aware of it. Some time ago a patient came to me from South Africa, complaining that he was losing his head. He had a large business, and whenever he sat down to his account-books he could get along pretty well for five minutes, and then he said everything seemed to go round and he could not add two and two together. Upon examining him I found

him perfectly healthy in all respects, excepting that his eyes were becoming presbyopic. The consequence was that when he attempted to do his accounts he was able by a powerful effort of the will to see the figures for a few minutes; then his power of accommodation failed, everything on the page became dim and blurred, and he could do nothing more. A pair of spectacles put him all right without the aid of any medicine whatever.

One very common form of headache commences in this way. The patient sometimes feels a little unwonted irritability at night, but this irritability is not always present. If it is so, it is very often the precursor of a headache. He awakes in the morning about four, five, or six, with a feeling of weight in the head, but not a headache. He is very drowsy, disinclined to rise, and is apt simply to turn over and go to sleep again almost at once. If he does this he awakes again about seven or eight with a distinct but not severe headache, usually frontal or temporal. As the day goes on the headache becomes worse and worse, until in the afternoon or evening it becomes almost unbearable. It then finishes up with sickness, after which the patient becomes easier, but feels much exhausted. A headache of this sort may frequently be prevented by the patient taking a mixture of bromide of potassium and salicylate of sodium overnight, or by getting up and taking it when he awakes with a heaviness in the early morning, instead of turning over and going to sleep again. The quantity necessarily varies with different individuals and with the severity of the headache; but thirty or thirty-five grains of bromide of potassium with five to fifteen grains of salicylate of sodium, in half a tumblerful of water, may be looked upon as an average dose. If the patient feels the irritability indicative of the approaching headache overnight, or if he should have the excessive brightness which is the precursor of headache in others, he should take this dose at bedtime, and will very probably awake without the headache. If in spite of it he should awake with a heaviness in his head between four and six, he should repeat the dose, or should take it for the first time if no indication of headache has been felt the night before, but the heaviness has come on during sleep. He will then probably turn round, fall asleep again, and awake without the headache. If, however, there should be either heaviness or headache on awaking about seven A.M., a third dose should be taken. I have tried both the bromide and the salicylate separately, but I do not think that they act nearly so well as when taken in combination. Only about ten

days ago I had a letter from a doctor who was suffering from a very severe headache after influenza. He had tried antipyrin, which had relieved it for the time, but had to be continued every twenty-four hours. He had also tried chloride of ammonium and bromide of ammonium with the same result. I advised him to try twenty grains of salicylate of sodium with forty of bromide of potassium in half a tumblerful of water, and after four doses of the mixture the pain subsided.

I have not used the bromide of potassium mixed with the salicylate of sodium for any prolonged time, but one patient of mine has been taking salicylate of sodium for her headaches for eight years. The headaches began to come on at the age of forty-two, and had lasted for twelve years when I saw her first on February 13, 1886. Two years after the headaches came on she had neuralgia, attacking the palate, ears, and side of the head, and when I saw her she had the pain violently just above the eyes. She had been a long time in India and had suffered from ague, but she had been well with the exception of the headaches. These came on every fortnight with violent sickness and intense pain which lasted sixty hours. She had tried iron, strychnine, and ipecacuanha, without any benefit, and vegetable diet did her no good. The only thing that was of any service was an injection of a third of a grain of morphine at a time. I advised her to take salicylate of sodium in twenty-grain doses three times a day, but she took it three times in the night, one dose at bedtime, one in the middle of the night, and one in the morning. This lessened the headaches from once in fourteen to once in thirty-two days. I advised her to take only half the dose of salicylate, but this seemed to do her no good, so, of her own accord, she reverted to the full dose. As her husband and I both felt anxious lest the continued use of the salicylate should prove harmful, we left it off from time to time, but these intermissions were of short duration. Thus she has practically now gone on taking it for about eight years.

Few of the minor ailments of life are more troublesome than headaches, for they not only cause much pain, but destroy one's power of work and capacity for keeping engagements. Twenty years ago we had very little power to prevent them or to cut short their duration, whereas now, by attention to the eyes and teeth, and by the use of bromides, salicylates, antipyrin, phenacetin, exalgine, and other remedies synthetically produced, nine cases out of every ten can either be cured or greatly relieved.

SOME DIFFICULTIES OF DIAGNOSIS IN HEPATIC DISEASE.

Paper read before the Medical Society of London, January 27, 1896.

(Reprinted from the *Transactions of the Medical Society of London*, vol. xix.)

In considering the subject of Difficulties of Diagnosis in Hepatic Disease, it seemed to me that it was of little use to attempt to give general principles, and that the best way in which I could utilise the twenty minutes at my disposal would be to take ten illustrative cases :—

Case 1. *Malignant Disease—Liver apparently Normal.*—The first case which I should like to mention is one that was sent to me by Dr. Stevenson of Grimsby. It illustrates the exceeding difficulty of arriving at an exact diagnosis in some cases of hepatic disease. The man, aged about 45, had been suffering from intense jaundice for two or three months before he came up to London. He was gradually losing strength, and was very anxious that something should be done to relieve him. On examination, a large tumour was found extending underneath the ribs on the right side, and clearly an enlarged gall-bladder. My colleague, Mr. Tom Smith, of St. Bartholomew's, opened the gall-bladder and attached it to the abdominal wall. The gall-bladder was found very greatly distended with bile, but no calculi were present. Three days afterwards the man died of collapse. It would, no doubt, have been put down as a case of death from the secondary effect of chloroform by some writers, who attribute cases of collapse occurring in this way to fatty degeneration of the heart from the action of the chloroform. Fatty degeneration of the heart was found, but in this instance ether was the anæsthetic employed. On post-mortem examination, the liver was found to be perfectly healthy. To all appearances it was of the normal size, and in passing the hand over it nothing wrong could be found with its texture, excepting that in one point, about the middle of the common gall-duct, a small nodule was felt about the size of an ordinary French bean.

A probe pushed into the duct from the duodenum was stopped by this nodule. A probe put into the duct from the gall-bladder was also stopped. It was impossible, however, even with the liver lying in the palm of one's hand, and feeling the nodule with the fingers of the other hand, to determine the nature of the nodule. It was only upon section that the nodule was found not to be a gall-stone, but to be the tail end of a piece of malignant disease about the size and shape of a Jargonelle pear. This case I think clearly shows the impossibility in some instances of arriving at an exact diagnosis.

Case 2. *Malignant Disease simulating Cirrhosis.*—The second case was that of a man, aged about 45, who had suffered for five years from indigestion. He had been very much worse for a year before I saw him. The dulness of the liver was three inches in the nipple line, its edge was somewhat hard. The diagnosis was cirrhosis. Shortly after I began to see him, the liver swelled somewhat, and I thought this was an attack of congestion occurring in a cirrhosed liver, but, instead of passing away, the swelling gradually increased, and in about three months the gentleman died of malignant disease of the liver, that organ becoming so large as almost to fill the abdominal cavity. One point that might have led us to a correct diagnosis was the constant persistence of disagreeable flatus, strongly smelling of sulphuretted hydrogen, and also another point, which was insisted upon by our President, who had kindly sent the patient to me, viz. that this gentleman, although a free liver, had never been accustomed to take spirits, but had always stuck to wine, and that of the best quality. The points here then that might have led to the correct diagnosis were the persistent flatulence of a disagreeable odour, and a history of the kind of stimulant that the patient was accustomed to take.

Case 3. *Probable Syphilitic Disease simulating Cancer.*—The next case is that of a man, aged about 45, who came to me with a liver reaching down below the umbilicus. There was no cardiac disease to lead to enlargement from passive congestion, and the diagnosis seemed to lie here, between either a syphilitic liver or a case of malignant enlargement. Iodide of potassium in large doses very quickly reduced the swelling, and in about four or five months the liver had returned nearly to its normal size. In this case the absence of jaundice and emaciation pointed to specific rather than malignant enlargement, but the diagnosis was first rendered certain by the effects of treatment.

Case 4. *Enlarged Liver—not Malignant.*—A similar condition

occurred in a man, aged 63, who was suffering from glycosuria. He had an enormously large liver, which under iodide went down, taking, however, as it decreased in size, a nodulated form, and ultimately it took a form very strongly suggestive of malignant disease, with a sharp nodule presenting downwards in the middle line. So much was this the case, that every time I saw him I said to myself: "If I saw this patient for the first time I should say he had malignant disease of his liver." But the progress of the case showed that it could not have been one of malignant disease, because the patient lived for a good many years, and ultimately died of abscesses in the leg, leading to septicæmia.

Case 5. *Enlarged Right Hepatic Lobe—Elongated Gall-bladder.*—The next case is that of a lady with a somewhat elongated thorax, and with a tumour, apparently connected with the liver, coming down nearly into the pelvis. The left side of this tumour was soft and elastic, the right side was hard and resistant. This was supposed to be a distended gall-bladder, the distension being probably due to obstruction of the gall-duct. The lady at the time was suffering from jaundice, and it was uncertain whether the gall-duct was stopped by calculus or by malignant disease. It turned out, however, to be a case of malignant disease. The post-mortem examination, of which Mr. Hartley kindly sent me the notes, showed that what we had taken to be an enormous gall-bladder was not really such a large gall-bladder as we supposed it, but was due to the curious shape of the liver. The right lobe of the liver was very greatly elongated, possibly in consequence of tight lacing, so that the hard resistant part, which we took to be probably a stone in the gall-bladder, was really the elongated right lobe of the liver.

Case 6. *Malignant Disease simulating Aneurism.*—The next case, a patient of Dr. Harper of Barnstaple, was a man, aged about 60, who had been failing in strength for eight or nine months. He had failed rapidly for two or three months before I saw him, and, several months before he consulted me, had an attack in Naples of what was presumed to be malarial fever, with severe rigors. When I saw him, he had a large rounded swelling in the epigastrium. This seemed, on pressure, to descend with the respiration, but the upper part of it was very pulsatile; so strong was the pulsation, indeed, that it really seemed to be a case of aneurism. Because the swelling descended with the respiration, I was inclined to suppose that it was a case of disease of the liver,

possibly gummatous, or possibly cystic. The patient was seen by another consulting physician, who found a murmur distinctly over the liver, and gave it as his opinion that it was a case of aneurism. Curious nervous symptoms set in, and the patient shortly died. At the post-mortem we found that this really was a case of malignant disease of the left lobe of the liver, the right lobe being almost entirely free. On section, the left lobe of the liver looked almost like a section of brain, but the right lobe was almost entirely healthy, there being only a very few white nodules scattered here and there throughout the substance of the organ.

Case 7. *Gall-bladder simulating Floating Kidney.*—The next case is that of a lady, a patient of Dr. Jeaffreson, who had had a gall-stone about a year before I saw her. She was at that time complaining of *malaise* and a little sickness. There was no very definite jaundice, however, and I found on examination a somewhat rounded swelling below the ribs. This was resonant on percussion. I found it somewhat difficult to move, but I could by gentle pressure force it up behind the ribs, very nearly in the way that one can usually press up a floating kidney. I gave it as my opinion that it was a floating kidney, and I advised the use of a bandage and a pad. These, however, gave little relief to the patient, and Mr. Knowsley Thornton afterwards examined the case. He himself will probably mention what his diagnosis was, but, at any rate, he advised an operation, and upon the operation being performed, a gall-bladder was found, with a number of stones. The operation proved completely successful in curing the patient. There was one point in this case which might be useful in the diagnosis of others like it. A floating kidney usually slips about on the slightest touch, but the tumour here required pressure to move it.

Case 8. *Gall-bladder simulating Floating Kidney.*—The next case that I have to mention I shall have to take at somewhat greater length. It is one in which I think the circumstances were such as to mislead one more than in most of the others. A lady, married, aged 32, was seen in June 1887, by myself and Mr. Willett. She complained of pain in the right iliac region of some two or three years' duration. Nothing could be felt or discovered on examination. The urine was acid and contained crystals of nitrate of urea, with a faint cloud of albumen, and once crystals of oxalate of lime were discovered in it. The pain, which came on in paroxysms, and passed down towards the umbilicus, was sup-

posed to be renal in origin. There had never been any jaundice. The patient returned to Java, where she had lived for many years, and remained there for five years. During this time she had several attacks of most severe pain in the right side, and on three occasions had what must have been attacks of peritonitis. In June 1893 she returned to London with a lump below the liver, which had been noticed for two years, and had been diagnosed in Java as an enlarged gall-bladder. There still had been no jaundice. She was again seen in June 1893, by Mr. Willett and myself, with the result that the swelling was taken to be a floating kidney. I am bound to say that this was chiefly my diagnosis, and that Mr. Willett was disposed to think that the swelling was a gall-bladder. The reasons that I had for believing that this was a floating kidney and not a gall-bladder were these:—That when the patient was lying, there was a tumour extending down from the ribs, upon the right side, to the umbilicus; when the lady stood up, this tumour descended still further, so that the upper margin of the tumour came to be nearly on a level with the umbilicus, while the lower end of it descended nearly to Poupart's ligament. On laying her upon her back, the tumour could be pushed up right under the ribs on the right side. In order to clinch the diagnosis, as I supposed, I put my fingers upon the tumour and held it down towards the pelvis. When the lady then expired, there seemed to be no dragging upon the tumour as I presumed there would have been from the ascent of the diaphragm during expiration, had it been a tumour of the gall-bladder, and I therefore came to the conclusion that the tumour must be a floating kidney, and in this diagnosis Mr. Willett agreed. From this time onward the lady remained in England, suffering pain from time to time, but never severe enough to lay her up. In January 1894 she became pregnant, and during the whole period of gestation suffered pain from the tumour. The child was born in September 1894, and on December 10, 1894, she was suddenly seized with severe pain in the side, and vomiting, and died of acute peritonitis. On December 2, during her last illness, the patient said her attack was similar to those she had in Java. The temperature rose to 107°; no food could be retained. During the attack the tumour was very tender. You will notice that in addition to the mobility of the tumour and its apparent disconnection with the liver, as shown by its not giving any sensation of being dragged upwards during expiration when held by the fingers, there was the

history of pain passing down towards the umbilicus. Now, Murchison says that in his experience, pain due to gall-stones is not reflected downwards towards the umbilicus, but only upwards. In this point he disagrees entirely with Trousseau, who states that the pain of a gall-stone may pass down towards the umbilicus instead of going up towards the trunk, as it usually does. On opening the abdomen, diffuse septic peritonitis was at once seen. The gall-bladder was greatly enlarged and distended, with nearly colourless viscid fluid and a large number of gall-stones. The largest gall-stone was nearly an inch in diameter, and was impacted at the neck of the gall-bladder. The gall-stones had set up inflammation in the gall-bladder, the wall at one place being no thicker than a piece of tissue paper. There was some suppuration into the gall-bladder at this place. No actual perforation was found, but it appeared that this suppuration of the gall-bladder was the starting-point of the fatal peritonitis. There was no disease of the stomach, intestines, or pelvic viscera. There was no stone or any other disease of the kidneys or ureters. In this case my statements regarding the position of the tumour in the various positions of the patient, are from notes taken at the time, but I have no note of the position of the edge of the liver and its relation to the tumour in these different postures, and probably I did not ascertain it, for at that time the idea that there might also be a loose attachment of the liver which would allow it to alter its place so much as to admit of such great alterations in the positions of the gall-bladder, never entered my mind. It is obvious that in any similar case this should not be omitted, and the lesson to be learned from the unfortunate issue seems to me to be that, where the pain is long continued, where it does not yield to remedies, and where the diagnosis is uncertain, it is better to operate, because the operation is likely to relieve the patient whether the disease be gall-stones or floating kidney.

Case 9. *Enormous Gall-stones without Hepatic Symptoms.*—The next case is that of a man who had no symptoms of gall-stone, no symptoms of disease of the liver at all. He one day appeared to get a chill by walking for a considerable distance very quickly, sitting in a cold tramcar afterwards, and then, when he got home, drinking copiously of milk. During the night he was seized with a severe attack of pain in the abdomen, and had all the symptoms of typhlitis. These symptoms continued at intervals for two or three months, and then finally he came to London. I may mention

here that while he was in South Africa, a tumour had been found nearly at the umbilicus, extending two inches above and two inches below the umbilicus, but when he came to London this had disappeared and a tumour was then to be felt extending from the ribs, on the right side, nearly down to the umbilicus. This tumour could not be very readily moved, and was hard upon pressure. It was opened by Mr. Treves, who found that it consisted of a gall-bladder nearly half-an-inch thick, and with several enormous gall-stones, six, I think, of about the size of a walnut, and two about the size of a hickory nut. The operation was completely successful, and the man went back well.

Case 10. *Obliterated Gall-duct and Absent Gall-bladder.*—The last case that I have to mention is that of a man, aged 60, who had suffered from gall-stones more or less for six years. When he came to this country he had lost weight very considerably, and he was not only much emaciated, but was of a very dark jaundiced colour indeed. The liver seemed to be slightly enlarged, but not very much, and there was a small rounded tumour under the ribs on the right side. This tumour I took to be an enlarged gall-bladder, and the case I supposed to be one either of impacted gall-stones, or of occlusion of the gall-duct from old cicatrices. I thought that in all probability it was not of malignant origin, because he had been at one time, four or five months previous to my seeing him, very much worse, very much thinner, and very much weaker than he was. The fact that he had, as it were, begun to recover before I saw him, seemed to put malignant disease out of court. He was operated upon in Edinburgh, and it was then found that there was no gall-stone; there was, indeed, no gall-bladder. What I had taken to be the gall-bladder was the omentum and the pyloric end of the stomach tucked up into the liver in the place where the gall-bladder usually ought to have been. The gall-ducts themselves were completely occluded by the pressure of old cicatricial tissue. The adhesions were torn down, thus gaining a passage for the bile through the gall-duct into the duodenum, and the abdomen was sewn up. The gentleman recovered, but presented afterwards a very curious colour, resembling, indeed, that of a person suffering from Addison's disease; so that at first there was some doubt as to whether the supra-renal capsule on the right side might not have been injured by the operation. He was treated with minim doses of tincture of supra-renal capsules. Whether it was due to this treatment or not, I

cannot say, but he gradually lost his strange colour, and one of the Christmas cards I had this year was his own portrait, to show how very much stouter he had got, and that he was perfectly well.

I fear I have exceeded my time, but I trust the cases I have referred to have been interesting and useful, especially those where a mistake has been made, and I hope the narration of them will enable others to avoid falling into similar errors.

JAUNDICE IN SOME OF ITS ASPECTS.

A Clinical Lecture delivered at St. Bartholomew's Hospital, January 31, 1896.

(Reprinted from the *Edinburgh Medical Journal*, New Series, vol. vi. p. 310.)

THE subject that I have chosen to talk about to-day is one of the cases which we lately had in " Elizabeth " Ward. You may remember that the patient was a woman, æt. 55. On looking at her, it was observed, first, that she was thin; secondly, that she was deeply stained of a yellow colour; and, thirdly, as could be seen, even from the other side of the ward, that the abdomen was greatly distended; so much was it distended, that it formed a large protuberance which was hardly covered by the bedclothes. First of all, on looking at her from the other side of the ward, it seemed probable that she must be suffering from cancer of the liver. The reasons for supposing that this was the disease with which she was affected were, that the abdomen was so distended and that the face was so thin. These symptoms indicated rather advanced disease of the liver, but these two symptoms might perfectly well occur without there being any malignant disease of the liver; because you can see precisely those same symptoms in a patient, æt. 41, in " Rahere " Ward. In this case the abdomen was just as large, the face was hardly so thin, but still it was thin. There was, however, one marked difference between the two: the woman in " Elizabeth " Ward was deeply jaundiced, the man in " Rahere " was not jaundiced; his face was sallow, but there was no jaundice. Now, when I went to examine the case in " Elizabeth " Ward, I expected to find the liver enormously enlarged; in fact, I had come to my diagnosis too rashly, and, as we often find when we act rashly, I was wrong. I percussed the liver, and I found that instead of being enlarged above the normal size, it appeared to be rather smaller; the edge of the liver could not be felt below the margin of the ribs. This, however, did not show that the liver was actually smaller, because it might have been pushed up by the distension

of the abdomen, and post-mortem examination revealed that this was the case—that the liver was very nearly of normal size, perhaps a little larger than usual. It was certainly not smaller than normal, and the apparent diminution in size was really due to displacement of the organ by its being pushed up by the intestinal distension.

In diagnosing a case, we have always to work backwards from what we see to what we do not see, and in both these cases we find abdominal distension, which is a common symptom. We may then take a little trouble over this symptom, and inquire to what it is due. Distension of the abdomen may be due to several causes. The most common of all is distension by flatus; next to that in frequency comes distension by fluid; and, lastly, distension by the growth of some solid mass contained in the abdomen. Not infrequently, we find that the distension is of a double origin, and consists partly of an increased amount of gas in the intestines and partly of an increased amount of fluid in the peritoneal sac. Now, we may proceed to ask, why is gas present in the intestines at all? Well, gas is present in the intestines of healthy persons, first of all because air is swallowed, and although the oxygen of the air is rapidly absorbed, the nitrogen does not so quickly disappear, and a good deal of that passes into the intestine. Secondly, a good deal of gas is apt to be formed in the intestines by the decomposition of food, and more especially of those foods which contain a quantity of cellulose, for, in its decomposition in the intestine, this substance seems to give rise more particularly to marsh gas: these are the two principal sources of gas in the intestines. But the gas would be much more plentiful in the intestines if it were not for the fact that a large proportion of it is absorbed by the vessels. This absorption occurs, for some gases, with great rapidity. For example, it occurs very rapidly in the case of oxygen, and also in the case of sulphuretted hydrogen. Sulphuretted hydrogen, indeed, is absorbed so rapidly from the intestine that it may give rise to poisoning and death. This rapid absorption was denied by Claude Bernard, who stated that sulphuretted hydrogen could not be absorbed so rapidly from the intestine as to produce any general symptoms, because, he said, although no doubt it is absorbed quickly from the intestine, it is so rapidly excreted by the lungs that you never get any bad symptoms from it. Orfila, from previous experiments, had come to a different conclusion; and Dr. Cash and I, when working at the action of carminatives upon the gases of the intestine, found that sulphuretted hydrogen could be so

quickly absorbed from the rectum and colon of an animal as to give rise to general poisoning. We therefore stated that a practice, at that time in vogue, of treating phthisis by injection of a mixture of carbonic acid with sulphuretted hydrogen was not without danger. It was at that time supposed to be absolutely harmless; but, unfortunately, shortly after our paper was published, a case occurred of death through the absorption of sulphuretted hydrogen, which had been given as a cure in a case of phthisis.

You can readily see that if absorption be lessened in any way through interference, for example, with the general circulation, by disease of the heart, or through local interference with the circulation in the abdomen by disease of the liver, there will be a tendency to accumulation of gas and to flatulence. Now, we find that flatulence is a marked symptom both in diseases of the heart and of the liver. You will frequently find that patients who are suffering from mitral disease complain very much of flatulence, and to this kind of flatulence the term "heart-wind" has sometimes been given. In the first stages of that disease of the liver, known as cirrhosis, where the portal vessels are just beginning to be slightly compressed by the contracting hepatic tissue, we find that wind is very apt to come on; that the abdomen becomes much distended, and, at first sight, we are tempted to think that the patient is suffering from dropsy. On percussing the abdomen, however, the whole of the abdomen may be resonant; there may be no dulness even in the flanks, or in any dependent part of the abdomen, and so we come to the conclusion that the patient is suffering simply from flatulence. As the contraction of the tissues around the portal vein goes on, however, we find a further symptom; not only is absorption of wind diminished, but absorption of fluid is also interfered with. The arteries supplying the abdominal viscera still carry on the circulation vigorously, a free flow of blood takes place through the intestines, and a quantity of tissue juice is effused from the capillaries; but instead of this being taken up by the radicles of the portal vein and carried on into the general circulation, the veins being obstructed, absorption is imperfect, and so the fluid tends to collect in the abdomen, giving rise to an accumulation of fluid in the large lymphatic, or peritoneal sac; for the peritoneal sac, as you know, is simply a large lymph space. In this space the fluid accumulates, so that in the later stages of cirrhosis we have not only a great amount of wind, but a great deal of water; and patients will very often tell you, when they are in the first stage,

that they themselves are afraid of water accumulating in the abdomen. Their fears are by no means unfounded, for, as a rule, the accumulation of wind is succeeded by the accumulation of water. Now, as I have just mentioned, this accumulation of wind and water has certain secondary effects. It tends to displace the diaphragm, to drive it upwards into the thorax; it interferes with the respiration, making the patient short of breath, and not infrequently it interferes with the heart, tending to make the patient giddy or even faint. You remember the position of the heart, diaphragm, stomach and intestines. Should the latter be distended by flatus, the diaphragm tends to be driven up, and if driven up by the distension of the abdomen it must needs displace the heart, and this displacement of the heart may give rise to certain circulatory symptoms, such as those of faintness. At the same time certain changes are produced in the size of the liver. In a normal condition of the liver the absolute dulness just comes to the sixth rib; but in the case of D. E. we found that the absolute dulness, instead of reaching the sixth, came up as far as the fourth rib, so that the position in which the man's diaphragm was standing was as I have mentioned, and it was this same displacement of the diaphragm that gave rise to the apparent diminution in the size of the liver in E. C.'s case.

We have now considered one at least of the most important causes of the distension which occurs in certain diseases of the liver, but there is another cause which must also be taken into account, that is, the possibility of increased circulation through the arterial system, viz. dilated arteries, as well as obstructed venules. If there is any irritant present in the abdominal cavity, it tends to cause dilatation of the arteries, and dropsy may occur without there being any very great obstruction to the backward passage of blood through the portal vein. This happens, for example, in cases of peritonitis, where there is no definite obstruction to the vein, but where the arteries become more dilated, as they always do in cases of inflammation, wherever the inflammation may be.

We may now turn from the symptom of distension to the other symptom which we found in E. C.'s case, and also in D. E.'s case, namely, of emaciation. You can readily see that such distension of the abdomen will tend to interfere mechanically with the taking of food, because pressure will be so exerted upon the stomach that it will not be able to take in food readily. But this is only one way in which interference with the liver tends to interfere with

digestion in the stomach. It is well to remember that all the blood in the stomach must find its way through the liver before it reaches the general circulation, and if the circulation through the liver is obstructed, congestion of the stomach is likely to result. This congestion of the stomach is very apt, indeed, to show itself by vomiting, and by a catarrhal condition generally. The catarrh you judge of partly by the appearance of the tongue, which is frequently thickly coated, but you become more certain of the existence of catarrh by the actual evidence of the vomited matters. When a person has catarrh of his nose, or, as we generally term it, a cold in the head, you may diagnose the presence of this cold from the somewhat nasal tone which his voice takes; but if you go entirely by the nasal tone you might be wrong in diagnosing a cold in the head, or, as we may term it, a catarrh of the nasal passages, in a stranger. It might be that he had got polypi in his nose and not catarrh; but if you saw him blow his nose and a quantity of mucus came out, your diagnosis is certain—that man has a catarrh in his nose. If you find that a patient brings up a large quantity of mucus when he vomits, then you know he has catarrh of the stomach. This catarrh is what we frequently find in cases of cirrhosis of the liver, and it often evidences itself by a tendency to retch or vomit in the morning just after the patient gets out of bed, and to bring up a thin, watery, almost tasteless fluid, with thick ropy mucus. So much is this the case, that we very often diagnose a patient's habits by the fact that he brings up this mucus and watery matter in the morning when he rises. Therefore, when a patient complains of this symptom, you generally ask him what he takes at night before he goes to bed, because whisky and water for supper are very apt to produce vomiting in the morning. In cases of life assurance, in which many of you will be probably concerned, it is a good thing to know that you can sometimes get useful information regarding the habits of your patient without his suspecting it. Possibly some of you know that life assurance societies are very chary about taking the lives of those who are addicted to intemperance; but if you ask the man who is proposing to insure his life whether he is intemperate or not, the chances are that you will hear that he is very temperate indeed; and if you ask him how much alcohol in any shape he takes in the course of the day, you will find that he mentions a quantity well within the normal limits of a temperate man. But if you ask him, "Have you a good appetite in the morning?" he says, "Oh dear no, I cannot eat my breakfast."

"You are sometimes sick before you take your breakfast?" "Yes, I am sick, and I bring up a lot of thick stuff, and sometimes a lot of water; I am always sick in the morning, and never have any appetite for breakfast." Then you know that your patient is almost certainly suffering from intemperance. It is not invariable; you will find the symptom in some cases of chronic malaria, where the liver has been disturbed by residence in the tropics for a number of years, and in bad malarial fever we get the same symptoms, although the patient may be perfectly temperate. But these two conditions, viz. gastric catarrh and hepatic congestion, are almost the only ones where you get this sickness in the morning and want of appetite for breakfast. From this interference with the stomach we have a lessened amount of food taken, a diminished quantity of food digested, and consequently there is a tendency to emaciation. The same thing holds good for the intestines, and the mere pressure upon the intestines tends to prevent accumulation of materials within them; we frequently find that in cases of interference with the circulation through the liver, the bowels incline to be loose, often being opened three or four times a day, or even more. In this there is a liability to lessened absorption even of such food as has been digested, and also a tendency to emaciation. There was emaciation in both the cases I have referred to, but in one of them we got no jaundice, in the other jaundice was present to a marked degree.

Now, jaundice depends upon the presence of highly-coloured matter in the tissues, and it reaches the tissues through the blood. When I was a student, the view was held that bile pigment was formed in the blood and was excreted by the liver. This view has now been given up, and it is now held that bile pigment is formed only in the liver. In my student days there were therefore two divisions of jaundice—one was called hæmatogenous and the other hepatogenous. The hæmatogenous jaundice was that due to increased formation of bile pigment within the blood and lessened excretion through the liver; hepatogenous jaundice was due entirely to the diminished excretion from the liver. This view of the hæmatogenous origin of jaundice was given up for a while, but it has now reappeared under a somewhat altered form. The altered form is, that we no longer consider that bile pigment is formed in the blood, but we do consider that alterations in the blood may lead to a very greatly increased formation of bile pigment in the liver; so that we may really get a kind of jaundice, the starting-

point of which lies in alterations in the blood. Although the pigment may not be formed directly in the vessels, yet it is formed from altered blood, and the alteration takes place in the liver; so that there is certainly some ground for the old view of hæmatogenous and hepatogenous jaundice. The hepatogenous jaundices are, however, much more frequent, and much more practically interesting, inasmuch as the hæmatogenous is generally associated with such severe blood changes that medical art has very little power over it, whereas over hepatogenous jaundice we are frequently able to exercise a great influence and to do in many cases a great deal of good.

Jaundice is generally due to interference with the flow of bile out from the liver, and this may be due to many causes. One of the most common causes is a catarrhal condition, either of the duodenum or of the bile ducts. This catarrhal condition thickens the mucous membrane of the duodenum and tends to obstruct the opening of the common bile duct; or the catarrh may be present by itself, and so plug the duct by a thick cork, as we may term it, of mucus. This catarrhal jaundice is generally recognised by its having very few symptoms. The patient does not emaciate, and there is very little to be found on examination except that perhaps the liver is a little larger and a little more tender than usual, so that pressure upon it makes the patient wince. Catarrhal jaundice, as a rule, runs a course of its own, and although you may do some good, I confess that I do not think a very great deal can be done for it. As a rule, catarrhal jaundice runs a course of about six weeks. You may get it cleared away in less than that time, but I have never been quite certain whether its disappearance in a shorter time was due to the remedies or simply to the course of the disease.

There are two special classes of catarrhal jaundice, namely—(1) that which is due to thickening of the duodenum itself; (2) that which is due to the presence of mucus in the duodenum. In the case where the catarrh is present in the duodenum, it usually begins in the stomach, spreads to the duodenum, and then involves the bile duct; and the symptoms you get in such cases are, that the patient for two or three days before the jaundice is a little sick, a little out of sorts, has not very much appetite, and feels a little qualmish. In the cases where it seems to begin in the bile duct itself, there are no symptoms whatever, and the patient goes out one fine morning, and he meets a friend, who says,

"You are very yellow to-day." He goes back and looks in the glass, and finds that he is yellow, but if it were not for the yellowness he would be perfectly well; and he comes simply to get the yellowness removed. As a general rule, you give him a blue bill, or a pill containing either mercury or calomel. One generally gives a mercurial pill with some rhubarb, podophyllin, colocynth, or other purgative, and a saline aperient to follow. This I suppose sometimes does good; at any rate, it is the general treatment, and you may then prescribe some nitro-hydrochloric acid, bismuth, or salicylate of soda. All these drugs are used in cases of catarrhal jaundice; sometimes they do good and sometimes they do not.

Now, in the case under consideration, we had evidently two things to deal with. We had certainly obstruction to the bile ducts, and we had evidently obstruction to the radicles of the portal vein. The bile ducts might have been plugged by something else than a plug of mucus. Six weeks, as I have said, is the usual course for ordinary catarrhal jaundice, but you may get a plug consisting of a solid gall-stone impacted in the gall-bladder, that may remain a very long time. As a rule, however, such an impaction is preceded by a considerable amount of pain. Then, again, you may have a pressure exerted upon the gall-bladder by something without. I shall read this case, because it is one of great interest; and I may tell you that my diagnosis was malignant disease of the head of the pancreas, because I found the swelling of the abdomen and this interference with the bile duct, which was clearly due to something that involved the bile duct and the radicles of the portal vein, not the portal vein alone, nor the bile duct alone, but the two together. In the case of the man in "Rahere," we had distension, emaciation, and symptoms of interference with the portal circulation, but there were no symptoms of interference with the bile duct. In a case of catarrhal jaundice we find symptoms of interference with the bile duct, but no symptoms of interference with the portal circulation. As a rule, in cases of impaction of a gall-stone, there is interference with the bile duct, but no interference with the portal circulation. In the case which we are discussing, however, we have to deal with something that would interfere both with the portal circulation and with the bile duct.

It seemed to me, then, most probable that there would be some growth pressing upon the liver, affecting at the same time both the bile duct and the portal vein. This is met with not infrequently in cases of disease of the liver itself, where a malignant growth is

present in the body of the liver, and this was what I thought was present before I examined the abdomen. In such a case, we would almost certainly have had a large projecting liver, probably nodulated on the surface. This was not present, and I did not find anything that was increasing the size of the liver, yet I thought it was increased in size; I came, therefore, to the conclusion that there was something pressing very much upon the portal vein and the bile duct, and also seriously interfering with nutrition, because the woman was very much emaciated. My diagnosis, therefore, was malignant disease of the head of the pancreas, which was pressing on the bile duct and on the portal vein.

Now, you will see from the history of the case, and from the post-mortem examination, that although this was not altogether correct, yet the indications were to a great extent correct. What I ought to have done properly was to put an intermediate step as to what we really knew, or were almost certain was present, viz. that there was some growth pressing upon the bile duct and upon the portal vein at the same time, and then state as the next step—this is probably malignant disease of the head of the pancreas. I will say that there was a growth pressing upon the bile duct and portal vein, but whether the pancreas was involved I do not quite know. The head of the pancreas was hard, and a section will be made of it. Let me read the notes of the case.

E. C., æt. 55, married, was admitted complaining of weakness, jaundice, and pain in the back—weakness due to imperfect nutrition, jaundice due to pressure upon the bile duct. The pain in the back was not definitely explained. She was well until four months ago, when she sustained a severe mental shock concerning family affairs. Soon after this she noticed her motions white—interference either with the flow of bile or pancreatic juice into the intestines, because white motions do not always indicate interference with the flow of bile, but may be due to interference with the pancreatic juice. Her skin was becoming yellow. This clearly showed obstruction to the flow of bile. At the same time the urine became very dark in colour, and she began to have pain in the back, the darkness of the urine going with the yellowness of the skin. Jaundice came on gradually, and there had never been severe attacks of paroxysmal pain. This seemed to indicate that we had not to do with any gall-stones, because in a gall-stone the jaundice comes on, as a rule, very suddenly, from impaction of the gall-stone in the duct. Since Christmas the abdomen has begun

to swell. Vomiting has been very persistent. There is much difficulty in keeping down even fluids; never any blood in the vomit. She has lost flesh all the time. On admission she was deeply jaundiced and very emaciated, with very little appetite. There was a yellowish-white fur on the tongue, which was moist; there was a quantity of bile in motions, which was a curious point. The abdomen was thirty-eight inches round; dull everywhere in the umbilical region. Change of dulness from side to side was readily obtained. The liver dulness commenced under the lower border of the fifth rib in the right axillary line. The organ could be felt below the costal arch anywhere. No other organ felt. There was a little dulness in the lungs, with deficient respiration, and so on, but nothing of any great importance; the heart apex beat in the fourth space, no murmur. There is a considerable cloud of albumen. The abdomen was tapped, and nine pints of fluid deeply tinged with bile were removed. The patient was eased for a little while, but not for long, and she very quickly filled up again and sank.

At the post-mortem examination it was found that practically most of the organs were healthy; the abdomen contained a certain amount of fluid. But here is the interesting point—the great omentum was enormously infiltrated with new growth, the lesser omentum was almost equally infiltrated. The whole of the peritoneal surface was dotted with new growths, especially well marked in the pelvic region, and some of this growth had become ulcerated. The retroperitoneal glands were infiltrated, and the mesentery was shortened and contained much fat. The intestines were matted together by some scanty adhesions, which easily broke down, so that the small intestine was removed with no difficulty, but the cæcum was fastened down so as to cause some difficulty in getting it away, also the ascending colon. The gall-bladder was not enlarged, but it contained one hundred and fifty-three gall-stones, although, note well, the woman had never had any symptoms of gall-stone; and this is a point to be very carefully borne in mind, that you may have large numbers of gall-stones in the gall-bladder and never a symptom of gall-stones at all. They varied from the size of a pin-head to that of a small marble, were brownish-black in colour; also some granular detritus. The wall of the gall-bladder did not seem to be involved in the new growth surrounding it at its upper part and filling up the portal fissure. The duct and portal vein were both lost in the great infiltration of the

lesser omentum, and it was this new growth that was pressing upon both the portal vein and the duct. So complete was this pressure that no bile could be squeezed into the duodenum. Immediately in the neighbourhood of the portal fissure the new growth had extended into the liver. There was a small round deposit on the surface of the right lobe. The surface of the liver was thickened and adherent. The weight of the liver was seventy ounces; it was enlarged, but not much, and full of bile. The pancreas did not seem to infiltrate, but a piece of it has been sent to the museum for microscopical examination.

Here, then, is a case which shows you very clearly how far we are able to diagnose correctly certain conditions connected with the liver, and how far also we are liable to be mistaken. The indications which were afforded by the jaundice, the distension, and the emaciation, clearly pointed to some growth interfering with the flow through the portal vein and through the hepatic duct. The emaciation indicated that the nature of this growth was malignant. The slow and gradual onset of the jaundice seemed to show that there was no gall-stone present, although, as we found afterwards, gall-stones were there. The slow growth would indicate, I ought to say, that the disease was not due to gall-stones, and due to impaction of the gall-stone on the duct. This long continuance indicated that it was not of a catarrhal nature. I was practically driven to the conclusion that there was a growth somewhere in the portal fissure, and probably it was at the head of the pancreas. So far as the diagnosis was concerned, *i.e.* that there was a growth pressing upon the portal vein and upon the hepatic duct, it was correct; and the exact nature of this diagnosis was also correct, in so far as a malignant growth was diagnosed. But the supposition was, that this growth started in the head of the pancreas, and then pressed upon the portal vein and the hepatic duct, whereas the growth appears possibly to have started around the gall-duct. It might have been due to the pressure of gall-stones, but it might also have been due, and in all probability was due, to the presence of an ovarian cyst which had ruptured and had caused irritation through the peritoneal cavity; for the whole of the peritoneum and the whole of the abdominal cavity were studded with new growths.

In this case, therefore, we have a well-marked instance of how far we can diagnose, and how far we are liable to error. The question of treatment in such a case was, of course, limited to the

amelioration of symptoms. All that we could do was simply to evacuate the fluid when it became so great as to distend the abdomen, to relieve the weakness by the administration of stimulants, to give such foods as could be kept down, and, where necessary, to ease the pain by morphine. More than that we could not do, but in some other cases we can do a great deal of good; the consideration of such cases we must postpone till another occasion.

ACUTE ATROPHY OF THE LIVER.

IN CONJUNCTION WITH F. W. TUNNICLIFFE, M.D.

(Reprinted from *St. Bartholomew's Hospital Reports*, vol. xxxii., 1896.)

ACUTE atrophy of the liver is a very rare disease. How rare it is may be inferred from the fact that in the statistics of this hospital we have only been able to find seven cases as having occurred in twenty-five years. Over 150,000 patients are treated either in the wards or casualty department of this hospital every year. If we reckon on this estimate the number treated in twenty-five years, it will come out at about 3,750,000, or in other words, we shall find that one case of acute atrophy of the liver occurs in about every 500,000 cases that apply to this hospital for treatment. Thierfelder,[1] in his article upon this subject in *Ziemssen's Handbuch*, was only able to collect from all sources one hundred and forty-three cases of primary acute atrophy of the liver in which the diagnosis had been verified by a post-mortem examination. Even when he admitted into his statistics those cases unverified by post-mortem examination, the number only amounted to two hundred. Henoch[2] has only observed three cases of acute atrophy of the liver in children, and only one of these was verified post-mortem.

This disease is naturally very interesting on account of its rarity. It is interesting also on account of its medico-legal relations, because it simulates acute poisoning by phosphorus so closely that it is difficult, or impossible, to distinguish a case of acute yellow atrophy from one of phosphorus poisoning unless by the history showing that phosphorus has been administered, by finding phosphorus in the vomit, or by noticing that the fumes which proceed from the patient's mouth or his breath are luminous in the dark. But acute yellow atrophy of the liver has another

[1] *Handbuch der speciellen Pathologie u. Therapie*, Band viii. p. 215. 1878.

[2] Henoch, *Vorlesungen über Kinderkrankheiten*. Berlin, 1881, p. 501.

interest, which is perhaps still greater. It is especially interesting at this period of the development of medical science, because just now pathology in its onward progress is passing from the consideration of the relationship between microbes and disease to that of the relationship between the products of microbic life and disease. It is beginning to look upon the symptoms of disease as caused not so much by microbes themselves, but rather by the poisons formed by them. We have, then, in acute yellow atrophy of the liver a sort of connecting link between poisoning by an inorganic substance, viz. phosphorus, and a disease or diseases, such as yellow fever, for example, which are most certainly due to microbes.

There is another disease due to microbes, viz. cholera, which resembles acute yellow atrophy, not in its symptoms, but in the fact that it, too, closely simulates poisoning by an inorganic substance—arsenic. The late Sir Robert Christison used to say that the symptoms of poisoning by arsenic were so very much like those of cholera, that he felt quite certain that cases of sporadic cholera occurring just about the beginning of an epidemic had been taken for cases of arsenical poisoning, and, *vice versâ*, that cases of true arsenical poisoning had probably been passed over entirely unnoticed during the height of a cholera epidemic. It is curious to note that the three different forms of cholera may be imitated by arsenical poisoning. In the first form there are symptoms of well-marked gastro-enteritis, violent vomiting, copious watery purging, followed by collapse and death; in the second, there is collapse without the previous irritation of the gastro-intestinal canal, the effect of the poison being exerted apparently chiefly upon the organs of circulation; in the third form, the poison exerts its influence chiefly upon the nervous system, and then there may be convulsions, delirium, and death.

Under the term primary acute atrophy of the liver are included those cases of icterus gravis, or jaundice with profound nervous symptoms, fever, and death, with or without the presence of leucin or tyrosin and a corresponding diminution of urea in the urine, in which no cause could be found, or rather was found post-mortem, for the acute atrophy of the liver which was present. Those cases in which a similar symptom-complex occurred during life, and a practically identical pathological condition was found after death, were, if phosphorus or antimony, for instance, were found in the stomach, called phosphorus or antimony poisoning, the essential difference between the two classes of cases being the finding of an

irritant poison in the one case, and the non-finding of it in the other. Another class of acute yellow atrophy seems accompanied by the presence of micrococci in the biliary canaliculi[1] and liver cell detritus.[2] A third class of case is associated with the presence of micrococci in the hepatic blood vessels. The micrococci were seen in the portal canals filling the arteries, and in the peripheric part of the lobule between the liver cells, filling up apparently the capillaries between them.[3] Bouiet et Boy Tessier,[4] in a case of acute yellow atrophy, thirty-six hours before death obtained from the blood of the patient a micrococcus, which was also present in the liver and renal epithelium. The result of their inoculations is, however, not given. Before leaving this part of the subject, we think it will be well to mention three other conditions all due to causes widely different in one sense, but not so different in another, which closely resemble acute yellow atrophy of the liver. These three are (1) poisoning by phosphorus, (2) poisoning by lupins (so-called lupinosis), (3) poisoning by toluylenediamine.

Perhaps it would be best to recapitulate shortly here the symptoms of phosphorus poisoning. Phosphorus poisoning is also very rarely met with in this hospital. In twenty-five years we have only been able to collect seventeen cases, one of which was fatal. The rest all recovered.

It is not, however, so rare elsewhere, being very much commoner abroad in Germany, Austria, and France than in England. The deaths from phosphorus in England and Wales occurring in the ten years ending 1892, from all causes—*i. e.* accident, negligence, and suicide—amounted to 147.[5] It seems to be especially common in Vienna, where a favourite method of commiting suicide consists in scraping the heads off two or three hundred lucifer matches mixing with water, and swallowing the mixture.

The symptoms in phosphorus poisoning are as follows:—First of all there are the ordinary indications of gastro-enteritis, and more especially of gastritis, as shown by pain in the stomach and vomiting. These primary symptoms pass off after a greater or less length of time, according to the treatment adopted. There is then

[1] *Klebs' Tagebl. des naturf. Vers. zu Leipzig*, 1872.

[2] Eppinger, *Prager Vierteljahrsch. f. prakt. Heilkunde*, 1875.

[3] A case of acute atrophy of the liver. Tomkins and Dreschfeld, *Lancet*, 1884, i. p. 606.

[4] Recherches sur le microbe de l'ictère grave. *Rev. de Méd.*, vi. p. 334. 1886.

[5] *Poisons: their Effects and Detection.* Wynter Blyth, Lond. 1895, p. 215.

an interval during which the patient appears to be almost well, but after a day or two new symptoms make their appearance, the patient becomes jaundiced, there is tenderness of the abdomen, and then nervous symptoms rapidly appear, delirium followed by convulsions, weak intermittent breathing, and death. There is only one symptom, practically, in which phosphorus poisoning and acute yellow atrophy of the liver have been said to differ, and this is in the interval which elapses between the primary and secondary symptoms in the case of phosphorus poisoning. This interval has been stated to be absent in cases of acute yellow atrophy of the liver. It will be noticed, however, that in the case of F. G., which we shall discuss fully later on, an interval did appear to take place between the primary and secondary symptoms, but this interval, although carefully marked and noted in the case before us, might have very easily been missed if one had not been on the look-out for it.

Another condition which has a close resemblance both to acute yellow atrophy of the liver and phosphorus poisoning is the disease known as lupinosis. This disease does not occur in man, but is responsible annually for the deaths of hundreds, one might say thousands, of sheep in Germany. It is contracted by the sheep as a result of eating certain kinds of lupins (*Leguminosæ*). The poison is contained in the husks of the seeds, and is soluble in dilute alkalies, and to some extent in water. Its actual chemical nature is unknown. It has received various names—Ictrogen,[1] Lupinotoxin,[2] etc.[3] The results of the ingestion of the poison are, vomiting, pain, and tenderness at the epigastrium and over the liver ; later, jaundice, with hæmorrhages under the skin into the muscles and serous membranes, twitching, paralysis, delirium, coma and death. On post-mortem examination the liver is found to be in a condition of acute yellow atrophy. The average course of the disease seems to be about a week. Two or three days generally intervene between the ingestion of the poison and the appearance of jaundice, then a rapid onset of the nervous symptoms occurs, which is soon followed by death. According to Liebscher,[4] the

[1] Liebscher, *Untersuchungen über die Lupinosen-Krankheit der Schafe.* Bericht aus d. physiol. Lab. des landwirth. Institnts zu Halle. Herausgegeben v. J. Kühn, ii. Heft, p. 53, 1880.

[2] Arnold u. Schneidemühl, *Vierter Beitrag Lupinose.* Lüneberg, 1883.

[3] *Vide* also Roloff : Über die Lupinose. *Archiv für Thierheilkunde*, Band ix., 1883.

[4] *Loc. cit.*

poison is of the nature of a toxin, and is produced by the agency of certain fungi.

The third condition, which is of special interest with regard to acute yellow atrophy of the liver, is toluylenediamine poisoning. This substance is a methylated aromatic diamine, of strongly basic properties. The action of this substance was discovered by Professor Schmiedeberg, and has been worked at by Stadelmann,[1] Afanassiew,[2] Hunter,[3] and others. The injection of this substance into the circulation, or into the stomach, causes a very profound jaundice. This substance exerts a destructive action on the red blood corpuscles, and renders the bile thick and viscid, so that it cannot flow through the bile ducts, which, at least in their smaller or capillary ramifications, become blocked by inspissated bile. If the drug is pushed to a fatal issue, the nervous system becomes affected, and the animal dies in a comatose condition.

To recapitulate then—Acute atrophy of the liver is interesting from a medico-legal aspect on account of the great similarity between it and phosphorus, arsenic, and antimony poisoning. It is also interesting in its relation to those diseases, such as yellow liver and cholera, which are due to specific micro-organisms. And lastly, it is interesting when compared with cases of poisoning due to other more complex organic substances, such, for instance, as toluylenediamine and the toxins in the condition known as lupinosis. Many of the products of the putrefaction of meat belong to the class of diamines; they are mostly substituted diamines, such as toluylenediamine. Some of these substances are non-poisonous, as, for instance, putrescine, cadaverine, etc.; some are poisonous, as collidine and muscarin, and the degree of their toxicity seems to be to some extent dependent upon the nature and extent of the substitution. Just now, when attention is being turned from bacteria themselves to their products as causes of disease, this subject is a particularly interesting one, for it seems as if the two cases which we are going to shortly describe form a connecting link between simple mineral poisoning on the one hand, and specific infective disease on the other.

One case occurred in a child, F. G., a boy, aged 3½ years. He was apparently healthy, and had been apparently more than usually healthy all his life. On November 9 he felt sick after

[1] Stadelmann, *Arch. für exp. Path. v. Pharm.*, Band xiv. p. 241. 1881.
[2] Afanassiew, *Arch. f. d. ges. Physiologie*, xxx. pp. 385—436. 1883.
[3] Hunter, *Journal of Path.*, iii., 1896, p. 259.

breakfast, he vomited after dinner, and from that time he continued to vomit everything that he took for two days, but no pain whatever was complained of, and the child went about as if comparatively little was the matter with him. After two days, on the Wednesday, the seat of the symptoms shifted. During the first two days the stomach was partly affected, but now the stomach appeared to get better, vomiting entirely ceased, and the milk which was taken was not only completely retained, but caused no pain. The liver, however, appeared on this day to become affected, because jaundice set in, and there was a certain amount of tenderness and pain complained of by the child in the abdomen, chiefly in the epigastric and hypogastric regions. But still the child upon this day was apparently very fairly well; he was able to go about as usual, and with the exception of the slight pain in his stomach and the slight jaundice, he was really to all appearances well. The vomiting had completely ceased, and the pain was not such as to attract much attention. On the Thursday, however, there was a marked change. After an apparent lull in the symptoms for twenty-four hours, the child began to suffer much more severely. He shrieked with pain, and was put to bed. The bowels had been constipated for two days; but after an aperient powder which was given to him the bowels were opened towards evening, and the motions were then of a dark-greenish offensive character. From this time forward the child became unconscious, and passed all his motions under him. Subsequently, and on until death, the nervous symptoms took the upper hand; the child became unconscious, delirious, and did not know his parents, and towards the end of the time, shortly after his admission to hospital, he had a convulsion—on the evening of Friday. Towards the midnight of Friday the breathing, which had before been somewhat stertorous, began to get feeble and intermittent, the coma deepened, and the child died. It will be seen that there is almost no difference between the symptoms presented by this case and the symptoms of acute poisoning by phosphorus. The diagnosis was therefore uncertain, the only way of making sure being to ascertain whether phosphorus or antimony was present in the contents of the stomach. This was done, and they were found to be absent; but, on the other hand, we succeeded in finding a body, or a mixture of bodies, which belonged to the class of substances known as diamines, but the specific reactions of which did not correspond to any known diamine.

The chemical tests, however, left little doubt that the substance was of the nature of a substituted, in all probability methylated, diamine. The changes which were found post-mortem were chiefly those of irritation of the stomach and intestines, a soft fatty condition of the liver, and a tendency to ecchymosis throughout the body generally. We ought to have mentioned that indications of these conditions were present before death ; that on admission the sound over the abdomen on percussion was tympanitic throughout, and yet on palpation the edge of the liver could be discovered coming down about two-thirds of the way to the umbilicus. The liver therefore was apparently enlarged, and yet it was soft and flabby, so that it fell back towards the spinal column and the intestines came in front of it. There was towards the end of life vomiting, first of all the matter looking like beef-tea, and consisting of altered blood, and later on of pure blood. There was further, as in toluylenediamine poisoning, an alteration in the blood, which was shown by the presence of little extravasated points, little ecchymoses upon the neck and upon the body. At the post-mortem examination ecchymoses were found on the pericardium. The liver was thin, and of a somewhat deep ochre colour internally on section, on the outside it presented a curious purple or lilac reflection. In this case the urine did not contain leucin or tyrosin. Bile pigment was present in large quantities, and a cloud of albumen.

There is a condition of the liver called red atrophy, regarding which comparatively little is known. It is, if possible, a still rarer condition than yellow atrophy, and so we have thought it worth while in this connection to relate a case which was admitted into the hospital a good many years ago. The patient, J. D. S., aged 43, a schoolmaster, was admitted March 7, 1889, and he died March 12, 1889. The history was that he had had a pain in the back, somewhat like a stiff neck, for about three weeks, but to this he attached little or no importance. On February 28 he had been dining with the other masters of the school in the middle of the day, and he had some kind of meat which they all noticed to have a somewhat disagreeable taste. He was, however, the only one who suffered from partaking of it. Between four and five on the same afternoon he had a kind of fit, like a fainting fit, but did not quite lose consciousness. He was sick once, and he slept fairly well that night, and had no symptom of any important kind, and more especially there was no trace of paralysis. Next day he did not feel very well,

and stayed indoors. The same was the case the day after, when he sent for a doctor. On the third day he again fell down in a fainting fit with violent pains in the head, and was then sick every quarter of an hour for twelve hours. His vision was not impaired; there was no diplopia; he had pins-and-needles all over the body; the voice was noticed to be husky, and he went to bed. On March 4 he had difficulty in swallowing liquids, although he could get down jellies. He further noticed that his vision was bad. On March 7 the condition was rather better; he lost control of the movements of the right hand from March 3, and he could not walk on March 7. He had no delusions, no dyspnœa, no difficulty in passing water, no girdle pains, no shooting pains in the legs. When admitted on March 7, his face was flushed, his manner was nervous, he felt rather shaky, his voice was nasal, his face moved slightly more on the left than on the right side; he had no headache, no pain anywhere. The pupils were both contracted, the right markedly so, it being half the size of the left. The pupils reacted well to light and accommodation; there was no nystagmus or strabismus. An attempt to swallow milk was unsuccessful, and brought on hawking. The milk did not pass up through the patient's nose, although he said that it would have done so had he not spit it out. The movements of the right hand and arm were disorderly and restless; there was no impairment of tactile and painful sensation; the liver dulness was normal, the spleen was not felt. We may pass over the remainder of the symptoms just now, only mentioning that the paralysis appeared to pass away and the patient's brain became affected, so that he was delirious, restless, and noisy, and had to be removed to the casualty ward, where he remained for less than a day. Shortly after being transferred there he vomited several times, the vomited matter being black. He could not sleep, but was constantly groaning; the pulse became almost imperceptible; the extremities were cold, and he died. The result of the post-mortem can be put very shortly. There was really no cause of death to be found. All that could be found in the body was some hæmorrhage into the cord, and a liver which was soft, small, and red. On pressing into it, it felt to one very much like the consistence of a typhoid spleen. It was very much softer than usual, almost diffluent, and Dr. Norman Moore, who was then pathologist, said that the only diagnosis that could be come to was that the patient had died of red atrophy of the liver. It is, however, to be noted here that the patient had no well-marked jaundice, and the symp-

toms which he presented were those of poisoning, although they did not correspond with those of any known poison. The contraction of the pupils, one would have said, pointed to something like physostigmine, but of course the other symptoms that he presented were not like those of physostigmine poisoning, and the curious fleeting character of the paralysis was very remarkable, because at one time there was marked ptosis in the left eye, and a short time afterwards this had apparently disappeared. The dysphagia, due doubtless to paresis of the muscles composing the pharynx and œsophagus, as well as the other paralysis, was almost certainly of peripheral origin, and further of peripheral nervous origin, *i. e.* due to paralysis of the motor nerve-endings in the affected muscular structures. This action of the poison in these two cases is especially interesting from the fact that the products of many bacteria, when injected into animals, exert this paralysing action, sometimes acting like curara on the motor nerve-endings of striped muscle, at other times like atropine, affecting chiefly the motor nerve-endings in unstriped muscle. The dysphagia, cardiac irregularity, and the other paralyses following diphtheria are phenomena of this class.

Taking these two cases together, then, we find that in neither of them was there any injury to the vital organs which was apparently sufficient to produce death. Both of them seemed to have died from the effect of a poison. We could not trace in either the one or the other any account of the administration of a poison either of an organic or inorganic nature, and we are practically forced to the belief that death in both was due to poisons formed within the bodies of the patients themselves by microbes, the nature of the microbes not yet being known. Probably if all the organs had been analysed with sufficient care one might have been able to separate from them some definite ptomaine or chemically allied body, but the amount of the diamine which we found in the stomach-contents of the first case was not sufficient to give conclusive evidence as to its exact nature, although there was no doubt that such a body, or a mixture of such bodies, was present. It would be beyond our purpose here to enter exactly into the chemical reaction upon which this conclusion is based. It is, however, of interest to mention that the substance obtained from the stomach-contents of the first case was poisonous, and when injected under the skin of a small guinea-pig produced a rise of temperature, twitchings of the limbs, followed by paresis and general lethargy.

A second dose produced identical symptoms, with the exception of the rise of temperature. In both instances the guinea-pig recovered. An examination of its urine showed the presence of peculiar crystals, which, however, we were unable to identify as certainly tyrosin, although they had many resemblances to tyrosin crystals. In the case of yellow fever, poisons have been separated from the contents of the stomach and intestines, and these are supposed to have the power of producing the disease in animals, or at least symptoms of the disease. Gautier,[1] in his work on toxins, gives a reference to a French work which we have not been able to consult in the original.

The symptoms in the two cases we have mentioned are those of gastro-intestinal disturbance, followed in the one case by jaundice, showing implication of the liver; in the other not followed by jaundice, but in both succeeded by symptoms of grave disease of the cerebro-spinal system. In the child who was admitted a very short time ago, the cerebro-spinal centres seemed to be involved; and in the case of S., the man who was admitted several years ago, the peripheral motor nerves seem to have been also affected. It is difficult, upon any other assumption, to explain the fleeting paralyses.

Now, there is one class of poisons that produce symptoms perhaps more nearly resembling those of acute yellow atrophy than anything else; we allude to some of the viperine venoms, *i.e.* venoms from various species of snakes of the viperine as distinguished from the colubrine class. These substances have the power of producing dissolution of the blood; they cause, when introduced into the stomach, very active vomiting indeed. They produce paralysis, weakness of the respiration, and consequent death, and not unfrequently death is preceded by twitchings, or even convulsions—a phenomenon which we have noticed as occurring in the case of the child with acute yellow atrophy, and which also occurred in the guinea-pig poisoned with the diamine which we obtained from the stomach-contents of this child. Perhaps you may be able to understand the occurrence of the different symptoms in acute yellow atrophy more easily by following them downwards from their cause to the appearances presented, than by following them upwards to their cause. Let us take it for granted that the poison, whatever it may be, tends to destroy the blood corpuscles, and therefore to produce certain symptoms. By destroying the blood corpuscles it will tend to cause jaundice, and jaundice of a

[1] Gautier, *Les Toxines*, Paris, 1896.

peculiar kind; because one of the noteworthy points in this case was that there was no obstruction whatever to the gall ducts. The bile could flow perfectly freely through all the ducts, and there was no obstruction by means of mucus or anything else. The mucus was not increased, and this is a point of considerable importance, for in many such cases the occurrence of jaundice has been explained on the supposition that the amount of mucus in the gall ducts was increased, and had offered an obstruction to the flow of bile out into the duodenum. This, however, did not occur here. The only way in which we can explain the occurrence of jaundice is by supposing that the bile had stayed in the capillaries of the liver, and had been absorbed back into the system. If there be no obstruction in the larger ducts, obstruction can still occur in the biliary capillaries in one or two ways: either the liver cells may swell very much, and thus obstruct the flow of bile through the capillaries so much that the tension in them being much increased reabsorption of bile may take place and jaundice occur. A similar absorption may take place if the bile contains such an undue proportion of solids that it is too thick and viscid to flow through the biliary capillaries. It will consequently stick in them and block them, more especially if at the same time the liver cells are somewhat swollen; thus the tension of the bile in the capillaries is increased and reabsorption takes place. This is probably the mechanism of the occurrence of jaundice in acute yellow atrophy.

Another interesting phenomenon occurring in these cases are the ecchymoses. They probably depend partly upon a dissolution of the blood, and partly upon some affection of the blood-vessels. The venom of the rattlesnake, when put upon the mesentery of a frog, will cause ecchymosis to occur to a tremendous extent. If you put a minute drop of the poison upon the mesentery of a frog spread under the microscope, things seem to be all right at first, but suddenly there is a flow of blood over the whole field, so much so that it is exceedingly difficult to make out the exact mechanism by which the blood finds its way out from the vessel into the tissue around it; so that the ecchymoses have a twofold origin, destruction of the blood corpuscles and partial degeneration of the vessels.[1]

With regard to the diagnosis of acute yellow atrophy, there is not very much to be said. At first it is impossible to recognise the difference between acute yellow atrophy and ordinary slight

[1] Brunton and Fayrer, *Roy. Soc. Proc.*, Feb. 18, 1875, pp. 270 *et seq.*

catarrhal jaundice. It can only be done when the symptoms characteristic of yellow atrophy, viz. the delirium, the altered respiration, the convulsions, and the coma, come on. The one diagnostic symptom in the course of the disease between it and poisoning by phosphorus, viz. the intermission which is said to occur in phosphorus poisoning and not to occur in yellow atrophy, does not seem to hold. In the case of F. G., as we have said, there seemed to be a distinct intermission, so that many people who believe in the statement that there is an intermission only in cases of phosphorus poisoning, and not in cases of acute yellow atrophy, would be inclined to class the case we had here as one of phosphorus poisoning. But against such a diagnosis is the fact that there was absolutely no history of phosphorus having been taken by the child, no history of any peculiar smell in the breath, no peculiar smell or appearance in the vomited matter, and an entire failure to find any evidence whatever of phosphorus in the contents of the stomach. This being so, we feel justified in diagnosing it as a case of acute yellow atrophy.

Treatment is practically nil. So far as is known, almost all the cases of acute yellow atrophy have died. It is said that some have recovered, and it has been stated that alleviation at least of the symptoms has been produced by free purgation. One can see that this would be to a certain extent a rational method of treatment, because if the symptoms depend upon the presence of a toxin in the intestine, clearing the intestine out, more especially by large doses of saline purgatives, will help to clear away the poison which has given rise to the symptoms. Thus one might hope, to a certain extent, for alleviation, if not complete recovery. Of course there is always this doubt in those cases that have recovered, viz. whether they were really cases of acute yellow atrophy or not. They may have been cases of phosphorus poisoning, because in the cases of undoubted phosphorus poisoning collected from the Hospital Reports during the last twenty-five years, seventeen in all, sixteen cases recovered and were discharged, while only one died. So that in cases of phosphorus poisoning, where quickly treated, the prognosis is good, and as the pathological conditions produced by phosphorus are so nearly allied to those which occur in acute yellow atrophy of the liver, one might hope that recovery would take place in the latter as well as the former condition. The difficulty, of course, is that before one thinks of applying the treatment for acute yellow atrophy the case is so far advanced that it has become almost

hopeless. The proper treatment would be to give saline purgatives in large doses just after the jaundice had begun, and before the graver symptoms, *i.e.* the nervous symptoms, had come on. But, on the other hand, one does not know that it is going to be a case of acute yellow atrophy of the liver until those symptoms do appear, and, therefore, the only rule to lay down is that perhaps it would be the best treatment in a case of jaundice, whenever there are indications of the approach of nervous symptoms, to purge freely, employing especially the salines, which would clear the intestine thoroughly out.

We have thought it advisable to append the clinical notes of the two cases, with the kind permission of Dr. Walker, under whose care J. D. S. was.

Case I.—J. D. S., æt. 43, schoolmaster. Admitted March 7, 1889; died March 12, 1889.

History.—Pain in the back like a stiff neck for three weeks.

February 28.—About one o'clock had for lunch some meat, which was noticed by himself and others to have a disagreeable taste. Between 5 and 6 p.m. had a kind of fit like a fainting fit. Did not quite lose consciousness. Was sick once. Was not paralysed after the fit. Slept fairly well that night.

March 1.—Stayed indoors.

March 2.—Consulted Dr. C. R. Walker of Leytonstone.

March 3.—Got up. Fell down in a fainting fit, with violent pains in the head. Was then sick every quarter of an hour for eighteen hours. Vision not impaired. No diplopia. Pins-and-needles all over body; not since. Voice noticed to be husky. Took to bed.

March 4.—Had difficulty in swallowing liquids. Can get jellies down with care. Vision bad. Was seen by Dr. Lauder Brunton in consultation with Dr. C. R. Walker. No objective signs of disease could be found.

March 6.—Dr. Walker noted paralysis of right pharynx and palate, with impairment of sensations of the same; right facial paresis with slight anæsthesia, also some paresis of right extremities and side. At times there is nystagmus (this was noticed on Sunday after the "fit"). He is being fed by peptonised beef suppositories.

March 7.—Admitted into St. Bartholomew's Hospital under the care of Dr. Lauder Brunton, and the following notes were made by the House-Physician, Dr. H. D. Rolleston :—

Felt rather better. Has lost control over movements of right hand since March 3. Found he could not walk. No difficulty in passing his water. No dyspnœa. Bowels open last on March 3. No delusions. No girdle pain. No shooting pains in the legs.

Is repeatedly exposed to cold, but not on one occasion more than another. No history of a blow on the spine. Has been working in a room without a fire. Denies morbus veneris. Usually a healthy man. Typhoid fever five years ago. Rather a nervous man. Never had a fit. Never had discharge from the ears. Mother paralysed for four years. Father found in bed dead, æt. 54 years. One of four. One sister "funny." No history of insanity.

Present condition.—Face flushed. Manner rather nervous. Feels "shaking." Voice nasal. Face moves slightly more to the left than to the right. No headache. No pain anywhere. Pupils both contracted, the right markedly; right pupil is half the size of the left; pupils react to light and accommodation. No nystagmus. No strabismus.

Ophthalmoscopically.—Right disc swollen. Margin indistinct. Vessels congested. Left fundus normal.

Tongue protruded without tremor and fairly straight. Furred on dorsum. Edges red. Palate moves. Back of larynx covered with mucus.

An attempt to swallow milk was unsuccessful, and brought on hawking and cough. The milk did not on this occasion come through patient's nose. He says it would if he did not spit it out. Unable to stand. Tendency to fall towards the right. Grasp of hands equal. No paralysis of any limb. Movements of right hand and arm disorderly and restless. No impairment of tactile or painful sensation. No formication. Knee-jerks present. No ankle-clonus. No cremasteric or abdominal reflex.

Abdomen.—Liver dulness normal. Spleen not felt. No dulness above the pubes. Passed urine naturally. Urine 10.23, acid. Trace of albumen.

No bed-sore. No pain on percussing any part of the spine.

Thorax.—Movement unimpaired.

Heart: Dulness normal. Impulse diffuse. Apex in fourth space half-an-inch inside the nipple-line. Sounds clear.

Lungs: Percussion good. Sounds clear.

March 8.—Slept comfortably last night. Nystagmus. Manner strange.

March 9.—Tongue furred on dorsum. Did not sleep well. Swallowed some jelly this morning. Said he would go out if not fed with solids. He was seen by Dr. Church this afternoon. Dr. Rolleston writes: "Dr. Church did not feel quite easy about him. Whatever else the patient might have the matter with him, there was some insanity about him. His manner had not struck me till this afternoon, when he certainly got very excited when made to walk."

March 10.—Swallowing all night. Sleepy. Drowsy. No pain. Tongue foul. Voice nasal. Pupils equal, somewhat dilated.

March 11.—Noisy night. No sleep after sulphonal grs. xx. Poor pulse. Has had some occipital headache. Strange, but easily managed. Tongue edges red. Dorsum furred. Takes fairly. Continually groaning, and behaving in a quite idiotic fashion. 3.15 p.m., transferred to private room.

Patient has been very restless ever since he came down from the ward to private room, talking a good deal. Took about half an ounce of brandy and milk by mouth, and has been very sick on and off all the evening. Black-looking vomit. Had an enema composed of an egg, brandy, and milk at a quarter to six (4 oz.); also a Slinger's suppository at half-past seven. Temperature, 96°. Bowels not open. Has not passed water.

10.15 p.m.—Patient had an enema of 4 oz. beef essence, 1 oz. wine. Vomited a small quantity of black vomit. Very restless.

12.30 a.m.—Had enema, 1 oz. brandy, 1 oz. essence, 15 grs. chloral. Breathing seemed easier.

2 a.m.—Died. Just before dying vomited, bringing up small quantity of black vomit.

Post-mortem (March 13).—No cause for death found by naked-eye examination.

External appearances.—Well made, muscular, well nourished. Rigor mortis gone from arms; present in legs. All internal organs somewhat soft and flabby, suggesting an early stage of decomposition.

Head.—Brain: Some general softness, probably commencing decomposition. No naked-eye lesion.

Spinal cord.—A little blood in arachnoid on its posterior aspect, forming a leash of distended veins. Cord, membranes, and spinal column normal to naked eye.

Chest.—Œsophagus: Some longitudinal streaks of pigmentation at lower edge of œsophagus. Vagi and sympathetic of neck seem

perfectly normal. Lungs: Some emphysema and congestion. Small white spots on pleural surface of upper lobes. Heart: Rather larger than normal. Slight patch of atheroma on mitral valves; otherwise no disease.

Abdomen.—Peritoneum: Much fat in mesentery and omentum. Stomach: Mucous membrane covered with thick darkly-stained mucus. Intestines: Normal, lumpy, somewhat pale stools in the bowel. Coats themselves were normal. Liver: Bile in bladder very black. Some slight adhesion of liver to diaphragm. Liver small, weighing 42 oz. Capsule smooth, not wrinkled. Section rather flabby in consistence (? decomposition). Lobular structure visible. Other organs normal, except kidneys, which were soft.

Case II.—F. G., aged 3½ years. Admitted November 13; died 1 a.m. November 14, 1896.

History.—Child been very healthy all his life. After breakfast November 9, retched; vomited his dinner same day.

November 10.—Better.

November 11.—Vomited everything he took, but complained of no pain. Child complained of pain in epi- and hypogastric region.

November 12.—Morning, child ran about; 2 p.m. he screamed with pain, was put to bed, and rapidly became unconscious. Bowels had been constipated for two days, but after an aperient powder he passed a green offensive motion on evening of 12th; from this time everything was passed under him.

November 13.—Condition upon admission.—Deeply jaundiced, petechiæ over body and neck. Face slightly flushed. Chest moved freely, no cough; alæ nasi did not dilate; lungs normal. Respirations 34, quiet, but occasionally with a sigh. Cheyne Stokes breathing absent.

Circulatory system.—Pulse 134, otherwise normal.

Nervous system.—Pupils dilated, veins of retina swollen and full. Outer side of left disc looked blurred. Nystagmus. Arms and legs rigid.

Abdomen retracted, resonant, tender to manipulation. Edge of liver felt two-thirds of distance between umbilicus and ensiform cartilage.

Considerable dysphagia.

Temperature on admission, 98·4°; 7 p.m., 99·4°; 9 p.m., 100·00°; 11 p.m., 102·8°. Soon after admission convulsion occurred, followed

by vomiting, first of altered milk, then of blood. Respiration became stertorous and irregular. Condition deepened into coma, and death took place about 1 a.m., November 14.

Urine post-mortem.—No blood, no sugar; trace of albumen; no leucin or tyrosin. Bile pigments.

Post-mortem notes.—November 14.—3 ft. 2 in. high, well nourished, markedly jaundiced. Petechial eruption on trunk and neck, and to some extent on limbs. Bruise on right frontal eminence. Rigor mortis not present.

Brain.—44 oz.; bones, membranes, and sinuses normal.

Eyes.—No evidence of disease of discs or choroid. Ears, no otitis media.

Chest.—Œsophagus, larynx, trachea, natural. Lungs, R., 6 oz.; L., 5 oz.; collapsed in places, crepitant all over.

Heart.—Natural weight, 3 oz. Sub-endothelial hæmorrhage in left ventricle. Pericardial fluid bile stained.

Stomach.—Bile stained; contained 3 oz. sweet-smelling blood-stained mucus. Mucous membrane softened and shaggy. Cardiac end of stomach apparently healthy, and sharply defined from rest of mucous membrane.

Intestines natural, except for a number of petechial spots on peritoneal surface.

Liver.—Weight 22 oz., pale, with ill-defined lobules on section. Portal vein natural. Liver edge firm and sharp. Areas of better defined lobules present, with pinkish spots. Gall bladder and ducts natural and free from obstruction.

Spleen.—4 oz.; natural.

Lymphatic glands enlarged. *Kidneys, ureters,* and *bladder* natural,

[We owe the notes of this case to the House-Physician, Dr. Hedges.]

BILE, BILIOUSNESS, AND GALL-STONES.

Presidential Address delivered before the North-West London Clinical Society at their Annual Dinner, October 24, 1899.

(From the *Clinical Journal*, vol. xv., No. 12, January 10, 1900.)

Gentlemen,—I must begin by thanking you for the honour you have done me in electing me your President. As such I have to deliver an address to-night.

Most of you know from Mr. Barry's play, *The Little Minister*, that there is in existence in Scotland a sect called "Auld Licht." Now, the ministers of this "Auld Licht" used to give very long addresses; and when they were called upon to say a grace before meat, this grace became so long that, although it could not properly be called a sermon, it very properly was called an "address." I do not believe, however, that any one of them had so much time allowed him for such an address as I have, because I see I am allowed no less than one hour. I hope I shall not occupy the whole of that time.

I have chosen as an appropriate subject for a before-dinner address, "Bile, Biliousness, and Gall-stones." Now gall-stones are definite enough, we can see them, we can handle them, and we can analyse them. But biliousness is not quite such a definite subject. We are all convinced we know what it is; some of us, alas! know only too well. But it is not quite so easy to define it. When we come to put the symptoms together, we find that some of them relate to the appearance, others to the digestive system of he unfortunate patient, and others again to his nervous system. In regard to his appearance, his friends will say to him, "You are not looking well to-day; you are sallow, your eyes are just a little yellowish, you are looking depressed." The patient himself feels that his appetite is not so good as usual, that he rather dislikes than likes the idea of food, and he has a sort of uncomfortable feeling about his epigastrium. Sometimes the bowels are out of order, he

is troubled with a little flatulence, and sometimes even with a little discomfort almost amounting to pain. His nervous symptoms are partly felt by himself, but partly they make themselves evident to his surroundings, and especially perhaps to members of his own family or those who may happen to be under him in business. He feels miserable and low, he cannot concentrate his energies, he cannot think out the subjects he would like, he does not remember names so well as he should wish to do, he has got a weight in his head, and he has got a very low feeling in his stomach. His heart is down in his boots. But besides this he is irritable. His wife knows that full well, his family knows it full well, and more than that, he is very often conscious himself that his irritability is beyond what he is accustomed to feel under similar circumstances, so that, altogether, he is almost inclined to say to himself, "This is not me."

Well, these are the symptoms of biliousness, and when we come to inquire into the causation we find two very different accounts. There is the account of the man who is up in the newest pathology, who says that biliousness does not exist, that there is no such thing; it is misnamed biliousness, but it is catarrh of the stomach, and that if you were to look with the microscope at the stomach you would find proliferation of certain cells, with an accumulation of mucus here and there. Then the man in the street says biliousness is due to bile, and he adds, "I know it because I see it in the person's eyes," and he adds, "I know also if I have a blue pill one night and a black draught next morning the colour of my eyes gets right, my loss of appetite disappears, I get rid of discomfort in the epigastrium, and all my belongings know that I have got rid of my irritability." We find, then, that as the yellow colour due to bile disappears from the face and eyes the symptoms of biliousness also go, and I think we are really warranted in believing that biliousness depends very much upon bile.

But we next come to ask, "Is it really bile, or is it certain things which are associated with bile that cause all those symptoms?" They appear to be definitely symptoms of poisoning, and when we know that bile is reabsorbed in large quantities from our intestines every day of our lives, we naturally wonder why we are not always bilious. We notice, too, that in certain people biliousness is a recurrent affair, that in some people it will recur once a month, in others once a week, in others once every two or three days And the time at which it recurs varies very much in different

individuals, and in the same individual at different times or under different conditions. When a man has taken a lot of exercise in the open air, for example, he does not, as a rule, often feel very bilious, and the periods of biliousness are got over quickly. But when a man is cooped up, has a lot of rich food and takes little exercise, the attacks recur pretty frequently. We notice that an alteration in the kind of food also makes an alteration in the periods of biliousness. Put a man on bread and water and he will not be nearly so bilious as if you give him a big dinner daily. I am quite sure that Lazarus, who lived on the crumbs which fell from the table of Dives, was not often bilious; whereas I think it is very likely that Dives wanted a blue pill and a black draught every other day.

We see, then, that nitrogenous food seems to increase the tendency to biliousness. Fats have a similar effect, and what we are accustomed to term high living generally brings it about.

Now, some years ago an investigation was made into the physiological action of certain substances that are formed by splitting up albuminous articles of food during the process of digestion, and it was found that the foods that we eat are capable of yielding poisons that will destroy us if they pass directly into the circulation. But, as a rule, they cannot do this; they have to pass through the liver on their way, and there some of them are caught, and passed back by the liver into the intestine with the bile, whilst others are actually destroyed. This is true not only of the poisons formed from food, but of actual poisons formed in other ways, such as the Indian poison, curara, and others of like kind. Now, we usually say "as bitter as gall," and we are accustomed to associate bitterness with bile. But fresh bile is not bitter. I was once making some experiments on myself regarding the action of digitalin, and I took a big dose, so big that I nearly, but not quite, killed myself. It made me very ill, however, and I vomited violently. I brought up something which appeared to be undoubtedly bile, because it was like yolk of egg, and it could not be anything else, but it lacked the characteristic bitterness. Now this bile was probably freshly formed. In the ordinary course of things it would not have been vomited, but under the influence of the poison it was brought up. Some time afterwards I had a letter from a doctor who had under his care a patient with a permanent biliary fistula, and he discovered in his patient also that fresh bile is not bitter. Whence comes the bitterness, then, that is associated with the

name of gall? In all probability it comes from the absorption from the intestine of bitter substances formed during digestion. These are absorbed by the portal system, carried to the liver, and stopped there on their way into the general circulation, so that, instead of being allowed to proceed on to the heart, to the brain, and to the various organs of the body, these bitter substances are turned back and are excreted again in the bile. You can see, then, that if bitter substances are constantly being formed in the intestine by the process of digestion, and constantly being absorbed and turned back in the bile, the bile itself will become very bitter after a certain length of time, varying with the amount of these bitter substances. And this, I believe, is the cause of the bitterness of bile and what we call biliousness. I believe that after a while the power of the liver to arrest these substances is exceeded, and that it cannot pass them all back. Consequently some go on, and give rise to symptoms of poisoning.

How, then, are we to prevent such a condition from occurring? One method is the old-fashioned one of a blue pill or a mercurial of some sort taken at night, and a black draught in the morning. The black draught alone does not seem to have the same power; it does not clear the man out, as he says. But the combination of the two generally has the desired effect. Probably the mercurial tends to cause the bile either to be expelled from the gall-bladder or else to quicken the movements of the upper part of the intestine, of the duodenum, the jejunum, and possibly of the ileum, and thus to hurry the bile on before time has been allowed for its absorption. At any rate, we know that this combination of mercurial and saline is practically useful in removing bile from the body, and in removing the symptoms of so-called biliousness.

The second method is to cause the bile to be expelled from the liver. The process of excretion of bile takes place under very low pressure indeed. And I say the process of "excretion," because the liver, as I have already indicated, has a two-fold function: (1) it secretes fresh bile, and (2) it also excretes old bile. This was shown in a very ingenious way by Schiff. He took the bile of an ox and injected it into the duodenum of a dog. The dog secretes a yellowish bile, the bile of the ox is green. After the green bile had been injected into the duodenum of the dog, Schiff waited a certain time and then he found that the dog was excreting green bile. It was thus evident that the dog had absorbed the green bile from the duodenum and was again excreting it into the gall-

bladder and through the common bile ducts. Now bile is secreted in the liver, and excreted, as I have said, under very low pressure, so low that very little resistance indeed is sufficient to stop its exit. If the duodenal mucous membrane become thickened, then of course the orifice of the common bile duct is to a certain extent obstructed ; and so the bile does not flow out into the duodenum in the way in which it would ordinarily do. Thus there is a good ground for some men saying that biliousness is due to catarrh of the stomach and of the duodenum. So it is. But it is not directly due to the catarrh ; it occurs because the orifice in the bile duct (at least that is my opinion) is slightly obstructed. We can get the same result, or still more markedly, if we obstruct the bile ducts in other ways. There is a drug called toluylenediamine which has the power of greatly increasing the formation of bile in the liver. It first of all increases the quantity, and then it causes the bile to be formed of such a thick consistency that it will not run through the small bile ducts. When this occurs jaundice is the consequence. And we all know that if the bile duct should be obstructed either by thick mucus in the duct itself, or by a stone in the duct, or by pressure upon the duct exerted by a bit of malignant growth, jaundice at once occurs.

Now another cause of the want of excretion of bile is the lack of *vis a tergo*. I have spoken of the obstruction in front, but a want of power behind is another common cause of the imperfect excretion of bile. Bile is excreted under such low pressure that it will hardly come out of the liver unless it be pressed out. In some experiments by a friend of mine, he found that when a dog was put under the influence of curara and then the liver exposed, no bile flowed out of the gall duct when he stopped the movements of respiration. If the movements were very slight the bile flowed out of the gall duct slowly ; if the movements of respiration went on very vigorously, the bile came out in a full stream. *The fact is that the bile needs to be squeezed out of the liver.* This is the reason, probably, that when no active respiratory movements are made people become so bilious. They may take the same food, yet if one day they are walking about briskly, and another day they are sitting quietly at home, they may feel perfectly happy during the exercise and miserable from biliousness while they are in the house.

How, then, are we to get over the difficulty ? The difficulty is to be got over by increased exercise, and that exercise must be of a certain kind. If you walk along the street your respiratory

efforts are very slight. The diaphragm moves but very little, and the abdominal muscles contract but very slightly. The case is entirely different if you start to walk up a hill, or even if you go up a long stair three steps at a time; because whenever you wish to make an effort, the first thing you do is to take a deep breath, so that the diaphragm descends on the liver, and when the muscles of the abdomen contract at the same time the bile is squeezed out of the liver. The ordinary exercise taken in climbing will therefore act as an antibilious remedy. When people cannot get this kind of exercise, we may supply it to a certain extent by making them go through one of the ordinary extension movements, commonly practised by recruits when they have just begun drill; putting their arms over their head, then stooping forward with their arms extended, and trying to touch their toes without bending their knees. In this way you get the liver pretty efficiently squeezed between the diaphragm and the abdominal muscles. Another is to row, because the movements of the abdominal wall and the movements of the diaphragm in rowing tend to compress the liver very efficiently. Where, as often occurs amongst patients, the subjects cannot get rowing exercise, you may replace it to some extent by making the patient go through similar movements with one of those exercisers known as Sandow's or Whiteley's. The same class of movements, in which the essential part is that the diaphragm and the abdominal muscles shall contract at once, may be carried out with these exercisers just as well in the patient's room as in the open air. They thus get the same effect on the liver as if they were to climb a Swiss mountain, although, of course, there is lacking in the confinement of the room the exhilaration which is obtained when climbing hills.

Now if bile is allowed to remain long in the ducts or in the gall-bladder it naturally tends to become thick, and although mere retention does not give rise to gall-stones, there can be very little doubt that the retention of bile is one of the things which favour the formation of gall-stones. I have had prepared some tables which show that gall-stones are very much more common first of all in the upper classes than in the lower, and secondly that you can divide the upper classes in this respect into sections. The section of the upper classes most free from gall-stones is composed of land-owners, whether they be small or large land-owners does not matter, they are men who occupy most of their time in the open air and have lots of exercise. In the section who are neither bad

with gall-stones nor very free from them come doctors, who get a good deal of exercise, but who, as a rule, do not get it quite in the same way as the land-owners. The land-owner goes out with his gun and has a good time of it; the doctor is either getting his exercise in the town or, if he is in the country, he may get it by riding; but some country doctors are obliged to drive, and so, of course, they do not get the same kind of exercise as the land-owners. The classes who are most predisposed to gall-stones are those who sit a great deal, those who are engaged in offices, and those who are teachers or professors; in fact, all those who are engaged in sedentary occupations are more liable to gall-stones.

Now I have said that gall-stones are definite enough when we see them, but they do not always express their presence in a very definite way. They may lie in the gall-bladder for a length of time without giving rise to any symptoms whatever; and they may be very big gall-stones, too; in fact, the big ones are very apt to lie quiet in this way, and the little ones are very apt to come out and give a great deal of trouble. Now little ones very often come out of the gall-bladder, pass through the cystic duct, and in doing so are just big enough to scrape through it and give rise to a lot of pain, but are not big enough to block the common bile duct, and so do not cause jaundice. I am certain that years ago I diagnosed a lot of cases of real gall-stones as cases of gastric neuralgia. The fact is that lately I have been very much astonished to see how many of the cases which I diagnosed eight or ten years ago as gastralgia have now come back to me with undoubted gall-stones. If the gall-stone is a little bigger, so that it blocks the common bile duct, it does cause a lot of pain, and not only pain but jaundice; so there is then little or no difficulty in diagnosing it. But when the gall-stone is very big it may sit in the gall-bladder quite placidly and give rise to no symptoms. The biggest lot of gall-stones, or, perhaps, I should say the biggest lot of big gall-stones I ever saw, were taken from a patient who never had a symptom of gall-stones. He came to me from South Africa, and he had a mass about the size of a cricket ball or a little larger under the ribs on the right side. It was as hard as a cricket ball, and when it was cut into it was found to be an enlarged gall-bladder three-quarters of an inch thick, and was simply packed with gall-stones as tightly as you could pack it. There were six or eight the size of a walnut, and two or three the size of a filbert.

They were all facetted so as to fit tightly against one another, and thus they made one solid mass.

We may suspect the presence of gall-stones when we find the symptom of pain coming on three or four hours after a meal and of a sharp character. Of course these symptoms are not unlike those of duodenal ulcer, which gives rise to pain in very much the same site as gall-stones, and it generally comes on about the same time, that is to say, when the food is leaving the pylorus. Just about this time the bile begins to pass through the gall duct, carrying with it a little gall-stone, if such a stone be present. It is sometimes by no means easy to differentiate between the two. Of course, one point about it is that gall-stones are not likely to come with every meal, whereas the pain due to duodenal ulcer is likely to occur after every meal. Then, in the case of duodenal ulcer you often get tenderness when pressure is made just behind the liver so as to catch the duodenum under the ribs at the back on the right side. But there is a method that I find very useful in diagnosing between gall-stone and duodenal ulcer, and that is the method of giving the patient a good big dose of bicarbonate of soda, a teaspoonful dissolved in half-a-tumbler or a tumbler of water, the patient sipping the whole of it. The pain in duodenal ulcer is due to the acid chyme from the stomach causing the ulcer to smart as it passes over it. If you neutralise the chyme and thus destroy its acid and stinging properties, the patient does not feel pain at the ordinary time. Therefore, if you find that a patient is relieved by big doses of bicarbonate of soda given in this way, you may be certain you are dealing with a case of duodenal ulcer and not with gall-stones.

We will now pass on to the treatment of gall-stone. During the passage of the gall-stone the only thing that really is of much good is the subcutaneous injection of morphia, but I have sometimes found in cases where the pain was not so very great, that a mixture containing ten minims of Hofmann's drops (Spiritus Etheris Compositus), ten minims of spirit of ether, ten minims of spirit of chloroform, and about a teaspoonful (that is to say, a drachm) of compound tincture of camphor, with some peppermint-water, very often seems to give relief. Another method that I have sometimes found of use has been that of giving chloroform where I did not like to give the morphia, or where the patient's friends said that the morphine did not suit. I have usually tried it first of all by putting the chloroform in a tumbler with a piece of blotting-paper,

which was large enough to take half-a-drachm of chloroform at a time, and let the patient inhale this. Of course, this is a kind of self-regulating apparatus, for as soon as the patient begins to go over, the hand falls down and the inhalation ceases. As soon as the pain comes back again, the patient raises the tumbler of chloroform to the nose, begins to inhale again, and the partial anæsthesia returns. I have sometimes found, however, that I could not relieve the excessive pain sometimes present in gall-stones by this method, and then I have tried a Junker's apparatus. With it I have succeeded in enabling the patient to obtain anæsthesia. This also is a self-acting apparatus, and I do not think there is much danger in its use provided the bottle be hung up on the end of the bed and taken charge of by some person other than the patient. As soon as the patient begins to work the ball of the apparatus the chloroform vapour passes into the nose or into the mouth, and in a short while the patient begins to go under. As soon as this occurs he ceases to work the ball, and then, of course, the chloroform stops and he begins to recover.

The treatment during the attack, however, is probably of a good deal less importance than the treatment during the intervals, the treatment by which we shall enable the patient to avoid, if possible, a recurrence of gall-stones. Practically I think there are three remedies for well-marked gall-stones. The first is Carlsbad salts drunk with hot water at home; the second is a visit to Carlsbad; and the third is the opening of the gall-bladder and the extraction of the gall-stones. Not infrequently one gets a good deal of credit for curing patients of gall-stones. I once did. I was said to have made a miraculous cure on a patient because I gave her something and she had no gall-stones afterwards, none of those severe attacks of pain for, I think, two years or more, although she had been having them constantly up to that time. I need not tell you that this was a mere coincidence. I happened to give her some medicine at the time she was having a specially bad attack, and that happened to be the last for a time. She might have had a dozen afterwards for anything the medicine had done to her, but she did not, and the medicine got the credit. In most cases if you inquire as to the habits of the patient who has suffered from gall-stones, you will find that he or she does not drink much water. Such patients will tell you they are not thirsty. But if you send them to Carlsbad they will be made to drink as much water in a month as would serve them in the ordinary way for a whole year.

Well, in order to prevent a return of gall-stones one of the things to do is to bring Carlsbad to the patient. Let such people take half-a-teaspoonful or a teaspoonful of Carlsbad salts dissolved in a tumbler of hot water and sip this in the morning while dressing. There are two kinds of Carlsbad salts; one is the crystallised salt and the other is the powder. The difference between the two is this: at Carlsbad they have got such an enormous supply of hot water that they use it to evaporate those parts of the water from which they wish to obtain crystals. Some Carlsbad water is put into large tanks, and underneath them fresh hot water from the springs is allowed to flow constantly, and the water in the tanks is thus evaporated until crystallisation occurs. Formerly the crystallised salts were taken out and the remaining liquor, which was called the mother liquor (Mutterlauge), was put into bottles. If you wished to make artificial Carlsbad water you had to mix both salts and mother liquor with hot water. Now instead of that the Carlsbad people evaporate the whole of the water, and in this way you get the whole of the salts contained in the Carlsbad water in the form of powder. This, I think, is rather better than the crystals. Kutnow's salts are ordinary Carlsbad salts with some effervescent powder added to them. Of course, many people take Kutnow's salts who will not take the other salts. They are no better, but they are more palatable.

Another remedy which is a good deal used is oil. This is a very curious remedy, because, as a matter of fact, we are accustomed to tell our patients that they are to abstain from all fatty foods; and yet, while during the day we tell them to abstain from fatty foods, we say to them, "Take half-a-wineglassful of good salad oil at night." This has been puzzling me for some time, because it seems as if we are cutting off the fat during the day and pouring it in during the night. There is no doubt that patients sometimes do continue free from gall-stones while they are taking oil. But at other times they do not, and I have never been able to satisfy myself that the freedom from gall-stones was really due to the oil. But I got a new light on the subject a little while ago from my friend Dr. Billings, who had been to Carlsbad on account of gall-stones. On his way back he had a very bad attack, and he said to me, "I do not think you were right in sending me to Carlsbad. Just think of the pathology of gall-stones. If you have a lot of gall-stones with plenty of thick bile around them, and perhaps a lot of mucus, they sit there in the gall-bladder and will not do

any harm. But if you send a man to Carlsbad and make his bile thin the stones will lose their padding, shake about in the gall-bladder, pass into the bile duct, and he will have a bad attack." Now, whether it is the oil which makes the bile thicker and makes the stones sit quietly in the gall-bladder I do not know, but oil does sometimes appear to prevent the patient from suffering from gall-stones.

The next point is the question of operation. I used to be very much afraid of recommending an operation for gall-stones. Now, however, I very rarely hesitate. Bearing in mind the intense suffering that gall-stones cause, I think there is hardly any one who knows the two sides of the question who would hesitate what to do. I know if I were suffering from gall-stone I should most certainly choose the operation. The only objection to it in many cases is the expense of it; if the operation were somewhat cheaper perhaps people would have it done more often than they do now. But still, most people would avoid operation if possible. And if there is anybody here who is afraid of gall-stones, I should say the best way to prevent the necessity for an operation would be for the patient to have hot water four times a day—on getting up in the morning, going to bed at night, at eleven o'clock, and at four o'clock, taking little or no liquid with meals, but taking the whole of his liquid in the shape of hot water at these times. In addition, let the patient buy one of those exercisers which I have mentioned, so as to squeeze the liver, and use it once or twice a day, say on going to bed and on rising in the morning.

Now, gentlemen, I have told you how to avoid gall-stones, I think, and how to avoid biliousness. But, unfortunately, the view of some doctors is that the function of the medical man is twofold: he has to tell people what they are to do, and, secondly, to show them by his own example what they are *not* to do. And now, I suppose, having finished this address, and discussed what people ought to do, we will now go to dinner and furnish an example of what our patients ought not to do.

ON THE ALBUMINOUS SUBSTANCES WHICH OCCUR IN THE URINE IN ALBUMINURIA.

IN CONJUNCTION WITH D'ARCY POWER.

(Reprinted from *St. Bartholomew's Hospital Reports*, 1877, vol. xiii.)

THE advances made by physiological chemistry during late years have been so rapid that it has been exceedingly difficult, indeed almost impossible, for any one busily engaged in practice to keep up with them. As the subject of albuminuria is one of great practical importance, and the discrimination of its different varieties may greatly modify the prognosis and treatment in any given case, we consider it advisable to begin this paper by a few words on the general chemistry of albuminous substances before proceeding to the special subject of the paper. For some readers this may be useful; for others it may be superfluous, but it is easy for these to pass it over. White of egg, or albumen, has given its name to the substances which more or less resemble it in their chemical reactions, and they are therefore termed albuminous. But white of egg contains other substances besides the constituent which gives its characteristic properties to it and forms the chief part of its bulk. To distinguish between the crude white of egg, or albumen, and its chief constituent, egg-albumin, the former is spelt with an *e*, album*e*n, and the later with an *i*, album*i*n.

The class of albuminous substances contains bodies which differ so much from each other that it has been found necessary to subdivide it into several groups. Hoppe-Seyler gives eight groups, which are—I. Albumins, II. Globulins, III. Fibrins, IV. Albuminates, V. Acid Albumins or Syntonin, VI. Amyloid, VII. Coagulated Albuminous Bodies, VIII. Peptones.

Two of these groups, viz. fibrins and amyloid substance, are only met with in the solid form, so they do not concern us in an inquiry into the nature of the albuminous substances which occur in solution in the urine. A third group, viz. coagulated albuminous bodies, also occurs only in the solid form. Five groups, therefore,

remain which occur in solution, and may consequently appear in the urine. These are albumins, globulins, albuminates, acid-albumins, and peptones. We may further classify these five groups into three divisions. *First*, Albuminous bodies in what, for convenience' sake, although not perhaps strictly accurately, we may term their natural condition, in which they are coagulated by boiling. This division contains albumins and globulins.

Second, Albuminous bodies in combination with acids and alkalis, and not coagulated by boiling. Albumins and globulins both combine with mineral acids and alkalis to form acid-albumins and alkali-albumins, or alkali-albuminates, as they are generally called. Thus, if we take a little white of egg dissolved in a quantity of water, we get a solution which is coagulated by boiling. But if we first add to it some very dilute nitric or hydrochloric acid (*e.g.* its own bulk of four parts commercial acid in 1000 of water), and then heat it, we may boil it as much as we please, but no coagulum will form. The albumin has combined with the acid and formed acid-albumin, which is not coagulated by heat. This is the reason why carelessness in washing out test-tubes sometimes causes the presence of albumin in urine to be overlooked. Let us suppose that a man tests urine in the usual way, either by boiling and adding nitric acid afterwards, or by nitric acid alone, and afterwards throws out the mixture of urine and acid. He then pours some fresh urine into the tube without washing it and proceeds to boil. The urine remains clear, and he supposes it to be free from albumin, yet it may be highly albuminous. For the acid diluted by the urine first tested clings to the side of the tube, and being thus heated with the second urine, gradually converts it into acid-albumin; and by the time the coagulating point of the unchanged albumin is reached, there is no longer any to coagulate, the whole having been changed into acid-albumin. By boiling a solution of white of egg or some albuminous urine with liquor potassæ, instead of dilute acid, the albumin in either solution will be converted into alkali-albumin, or alkali-albuminate, and will not be coagulated by boiling. By its conversion into acid-albumin or alkali-albumin, ordinary albumin undergoes another change besides the loss of its coagulability on boiling, for it also loses its solubility in water. White of egg, or the dried albumin from serum or urine, may be dissolved in water and give a neutral solution, but after it has been changed into acid-albumin or alkali-albumin it becomes insoluble in water, and is therefore precipitated from its acid or

alkaline solutions by neutralising them. When the point of neutralisation is passed, and the solutions rendered alkaline by alkalis or their carbonates, or acid by mineral acids, the precipitate is redissolved, but will again be thrown down by neutralising. But if acetic acid be used instead of a mineral acid to neutralise a solution of alkali-albuminate, the precipitate is not dissolved by a slight excess of acid. Indeed, when sodium phosphate is present in the solution, alkali-albumin is not precipitated by exact neutralisation, and the precipitate only falls after the liquid has been rendered acid. When we wish, therefore, to separate alkali-albumin from a liquid, we acidulate with acetic acid. By then boiling we can precipitate both the ordinary albumin and the alkali-albumin from a fluid which contains them, while if we boiled without previously adding acetic acid, the ordinary albumin only would be coagulated, and on removing it by filtration the fluid would be found to contain alkali-albuminate. But besides its use in precipitating alkali-albuminate, acetic acid possesses the power of causing ordinary albumin to coagulate more readily on the application of heat, and its addition to any fluid from which we wish to separate albumin thus serves a double purpose.

The *third* section into which we have divided soluble albuminous bodies contains only one group, that of peptones. These are albuminous bodies so much altered by the process of digestion that they are neither coagulated by heat nor precipitated by neutralisation. They are, however, precipitated by alcohol.

The presence of albumin in the urine is universally acknowledged to be a morbid condition, but its causation and significance are very varied. At one time it is a symptom of the gravest importance, at another it may be of very little consequence. This fact is of itself sufficient to show that under the general term albuminuria. many dissimilar conditions are grouped. Some of these have already been dissociated, and we recognise the distinction between the albuminuria of Bright's disease and that dependent on cardiac lesions. But besides these there are probably other forms of albuminuria, less common and less important, but yet deserving of more attention than they have hitherto received in respect to diagnosis, treatment, and prognosis. It was with the view of attempting to distinguish these, as well as with the hope of gaining some new insight into the ordinary forms of albuminuria, that we began our present research. The great differences which are observed in the behaviour of albuminous urine when boiled or

treated with nitric acid have led medical men to recognise that the albuminous bodies occurring in urine are not always the same; that two or more kinds of albuminous bodies may sometimes be present in the urine at once. Lehmann showed that paraglobulin is generally present in albuminous urine along with serum-albumin, and his results were confirmed and extended by Edlefsen and Senator. These observers dealt chiefly, however, with the albuminous bodies normally present in the blood, although Senator observed the presence of peptones. It is to the classic researches of Stockvis that we owe the first clear demonstration that albuminous bodies may be absorbed from the stomach and intestines, and excreted unchanged in the urine. Numerous experiments showed him that the serum of blood and the albumen usually excreted by the kidneys in Bright's disease were identical, and that when either of them was injected under the skin, or directly into the vessels of the animal, provided that the experiment was conducted in such a manner as not to disturb the circulation, the urine remained quite free from albumin, the healthy kidneys apparently refusing to let the albumin pass through them. But when egg-albumin, or Bence-Jones's albumin (a curious kind of albumin obtained from the urine in cases of osteo-malachia) was used, the result was very different, for both of these seemed to pass readily through the kidneys, and appeared again apparently unchanged in the urine. When taken into the stomach, raw eggs, as every one knows, are digested, and egg-albumin does not appear in the urine as a rule; but if the quantity of eggs has been too great for the digestive powers, the albumin is absorbed, and appears in the urine. Both egg-albumin and Bence-Jones's albumin are absorbed from the rectum, and appear in the urine. Nor is it only undigested albuminous substances which are thus absorbed and excreted. Claude Bernard observed that after partaking of a quantity of *cooked* eggs, his urine became albuminous. The coagulated albumen of cooked eggs could obviously not be absorbed without undergoing some previous change. But Kühne has found that the pancreatic juice, before converting coagulated albuminous bodies into peptones, seems to change coagulated albuminous bodies into something resembling their raw condition before converting them into peptones. In Bernard's observation the cooked eggs which he swallowed seem to have undergone this change, and then been absorbed in the same way as raw eggs would have been. The fact that absorption of albuminous substances does take place

from the intestine makes it appear extraordinary that albumin is not more frequently found in the urine during digestion, and one can only suppose the reason to be that it is only when the digestive powers are overtaxed, as by swallowing many raw eggs together, or deranged so as to digest the food partially but not completely, that such an event occurs. In a clinical lecture, published in the *Medical Times and Gazette* for April 10, 1852, the late Dr. Parkes noticed that in cases of albuminuria the albumin was much increased after meals, and he ventured the hypothesis that the albumin was of different quality, as well as increased in quantity. In the same journal, April 22, 1854, he discussed the origin of this increase, and distinguished it by the name of food-albuminuria. This food-albuminuria he considered was not due to congestion of the kidneys during digestion, for the water of the urine is often diminished, and the solids do not increase in proportion to the albumin. He therefore thought it might be due to albumin not being altered in the stomach and liver, and therefore being eliminated like white of egg. He called attention to the fact that the antecedents of Bright's disease are often such as to impair the functions of the stomach and liver, and that dyspeptic symptoms often appear before renal. In his work on the urine he also quotes the case described by Christison of a young man in whom cheese always produced temporary albuminuria, and who afterwards died of Bright's disease.

Similar observations to those of Parkes were made about the same time as his by Gubler, who communicated to the Société de Biologie, August 6, 1853, his observation that the amount of albumin was increased during digestion. He proceeded to try the effects of various diets on the patients, and found that, with an exclusively vegetable diet, the albumin sank to a minimum; that it reached its maximum on an exclusively albuminous diet, and was intermediate in quantity when the diet was mixed (article in *Dictionnaire Encyclopédie des Sciences Médicales*, 1865, tom. ii. p. 447).

This subject was again taken up by Dr. Pavy, who confirmed Parkes' results regarding the increase of albumin in the urine during digestion, and tried to ascertain experimentally whether or not Parkes' supposition were correct that the albumin found in the urine varied in character as well as in quantity at different times. It occurred to him that its occasional presence in the urine might be due to its diffusibility being greater at one time

than another. He therefore employed a dialysing apparatus to distinguish between the albumins, with the result of showing that very considerable differences exist in the readiness with which different specimens of albuminous urine pass through animal membranes. We quote the following passage from his Gulstonian Lectures for 1862 (*Lancet*, May 23, 1863): "On submitting some specimens of albuminous urine to dialysis, I encountered one where the albumin passed in considerable quantity. The urine was derived from a patient affected with phthisis, who never had experienced any symptom of dropsy. It was highly charged with albumin, and on being submitted to dialysis, using vegetable parchment as a septum, the albumin passed to such an extent that the diffusate, after twenty-four hours (distilled water had been placed on the other side of the membrane), gave a pretty copious precipitate with heat and nitric acid, as also with the yellow prussiate of potash and acetic acid test. It was noticed, as happens with some specimens of albuminous urine, that the precipitate produced in the diffusate, by the addition of a small quantity of nitric acid, was redissolved on agitation. A considerable excess of nitric acid was required to throw down a permanent precipitate. The same result was obtained on several occasions, and no idea could be entertained as to any imperfection in the dialyser, because the same one was used for blood and other specimens of albuminous urine, but albumin in neither case passed in twenty-four hours to any sensible extent. The patient left the hospital, and was readmitted six months later almost in a moribund state. His urine was still highly albuminous, but, curiously enough, now gave scarcely any positive result on being submitted to diffusion. Dialysed for forty-eight hours with a septum of vegetable parchment, the diffusate yielded only the slightest turbidity on being tested for albumen. Although I have met," he continues, "with differences in other cases, still with the specimens of urine I have as yet examined I have never encountered one where the albumin diffused to an extent at all comparable to that in the case I have just mentioned." Interesting as these observations of Pavy were, they do not seem to have been taken up and extended, probably because the method of determining the nature of the albumin was too troublesome to allow of its being applied readily in the sick chamber or hospital ward. In our present research we have endeavoured to distinguish the different albumins in urine by determining their coagulating points, because we wished to employ

a method which could be used at the bedside with such ease that, if it gave any useful indication at all, it might be universally employed.

The method simply consists in holding a thermometer in the urine while it is being very gently heated in a test-tube over a spirit lamp, and noting the temperature at which the urine begins to grow milky from the commencing coagulation. Instead of holding the thermometer with the fingers, it may be fixed in the test-tube by means of a conical india-rubber stopper, with a hole in the middle through which the thermometer passes. As one is apt to break the thermometer in pushing it into and drawing it out of the hole, it is well to split the stopper to its middle along its whole length. By opening the slit the thermometer can be put in and taken out, or its position altered, with the greatest ease, and the conical form of the stopper makes it fit a test-tube of any size. The apparatus we employed was somewhat more complicated, for instead of heating the urine in a test-tube directly over a flame, we suspended the test-tube in which it was contained in a beaker of water over a lamp, so that the urine was thus very equally and gradually warmed, and the temperature of coagulation exactly ascertained.

The first question which we tried to answer by this method was, Does the coagulating point of the albumin in albuminuria vary much?

From the following examples it will be seen that it does.

I. R. A., case of intermittent albuminuria. Coagulating point of one specimen of urine, 173° F.

II. J. V., albuminuria from pregnancy. One specimen coagulated at 150° F.

III. H. H., waxy kidney. One specimen coagulated at 164° F.

IV. Chronic Bright's disease. One specimen coagulated at 180° F.

V. Chronic Bright's disease. One specimen coagulated at 144° F.

But the coagulating point varies not only in different patients but at different times in the same patient. Thus in the case of H. H., although the coagulating point was usually about 164° F., it sank to 152° on one occasion, and rose to 171° F. on another. It is well known that variations in the acidity and in the amount of neutral salts of any albuminous solution greatly alter the

coagulating point of the albumin. Besides this, however, it seemed to us that the proportion of urea in the urine might influence the coagulating point of albumin, and the following experiments were tried to determine this point as well as the influence of uric acid.

Influence of Urea on the Coagulating Point of Serum-Albumin.

A solution was made of the dried serum of blood (serum exsiccatum), prepared by the evaporation of fresh serum at a temperature of 130° to 140° F. by Mr. Fore of Birkenhead at the suggestion of Dr. Vacher.[1] One part of this was dissolved in 2000 of water, and portions of the solution were mixed with their own bulk of solutions of urea of different strengths. The coagulating point was then noted.

The effect of the urea in altering the temperature of coagulation is apparent from the following table :—

Influence of Urea on the Coagulating Point of Serum-Albumin.

Strength of Solution of Serum-Albumin.	Strength of Solution of Urea.	Temperature of Coagulation 154°–158° F. without admixture.
1 in 2000.	50 per cent.	No coagulation.
Do.	20 ,,	168°–172°
Do.	15 ,,	166°–172°
Do.	10 ,,	166°–170°
Do.	5 ,,	162°–168°
Do.	1 ,,	168°
Do.	$\frac{4}{5}$,,	164°–166°
Do.	$\frac{1}{2}$,,	162°
Do.	$\frac{2}{5}$,,	160°
Do.	$\frac{1}{5}$,,	160°

Influence of Urea on the Coagulation Point of Egg-Albumin.

Strength of Solution of Egg-Albumin.	Strength of Solution of Urea.	Temperature of Coagulation 136°–140° F. without admixture.
1 in 20.	50 per cent.	No coagulation.
Do.	20 ,,	140°
Do.	10 ,,	140°
Do.	5 ,,	132°–134°

[1] Serum Sanguinis Exsiccatum, by F. Vacher. *Practitioner*, vol. xvii. p. 433.

In another solution of egg-albumin of similar strength the coagulating point was 138°–142° F., and admixture with an equal volume of 5 per cent. urea solution did not alter it.

It is evident from a consideration of the figures just given that although variations of a few degrees may occur in the observations without any apparent cause, except imperfection of the method of experiment, yet as a general rule the presence of urea in solution raises in a very marked degree the coagulating point of albumin, and when the quantity of urea reaches 25 per cent. of the solution (*i. e.* of the mixed solutions employed), the coagulation both of serum-albumin and egg-albumin is prevented. Egg-albumin was much less affected than serum-albumin, but this might be due to the different strength of the solution, and not to any difference in the reaction of the albuminous substances themselves.

The effect of uric acid on the coagulation of serum-albumin and egg-albumin was tried in a similar manner. We here give the results—

Influence of Uric Acid on the Coagulation of Serum-Albumin.

Strength of Solution of Serum-Albumin.	Strength of Solution of Uric Acid.	Temperature of Coagulation 160° F. without admixture.
1 in 2000.	Saturated.	144°
Do.	Do.	146°–150°

Uric acid is thus seen to have a depressing effect on the temperature of coagulation of serum-albumin.

Similar experiments made with egg-albumin seemed to show that it raised instead of lowered the temperature of coagulation, but this seems so doubtful that we must repeat our experiments on this point.

We may sum up shortly the results of this series of experiments, at least as far as regards serum-albumin, and also the results of previous observations on the effect of acids and salts, by saying that—

The coagulating point is raised by urea.

The coagulating point is lowered by uric acid, other acids, and neutral salts.

It is therefore evident that the urea will more or less counteract the effect of the acid and salts in the urine upon the coagulating

point of the albumin it contains and *vice versâ,* so that at one time they may completely neutralise one another, and the temperature of coagulation will then be the same as if neither were present, while at another the temperature may be either considerably above or considerably below that at which the albumin would be precipitated from a purely aqueous solution.

Effect of Dilution on the Coagulation of Albuminous Urine.

In order to get rid, to some extent at least, of the effect of the salts and of the urea on the coagulating point, we diluted the urine with water until it had a specific gravity of 1005. This altered the coagulating point, sometimes raising it, at other times depressing it, but it did not render the coagulating point constant, as will be evident from the following table:—

Case.	Ward.	Date.	Before Dilution.			After Dilution.	
			Sp. Gr.	Reaction.	Coagulating Point.	Sp. Gr.	Coagulating Point.
Gollop, Chronic Bright's disease.	John	Sept. 5	1019	...	131°–140°	1005	132°–137°
		,, 7	1020	...	124°–126°	1005	130°–135°
		,, 8	1021	...	128°–132°	1005	132°
Hill, Waxy kidney.	John	,, 5	1016	neutral	164°–170°	1005	164°–170°
		,, 8	1015	acid	160°–166°	1005	166°–173°
		,, 20	1015	acid	162°–166°	1005	154°
Juniper, Nephritis	Mark		1015	alkaline	162°	1005	152°–160°
Hunt, Nephritis	Luke		1019	acid	148°	1005	136°
Slater, Bright's disease.	Matthew		1032	acid	142°–148°	1005	142°
Cane, Bright's disease.	Matthew		1017	acid	134°–138°	1005	148°–150°

Experiments on the Coagulating Point of the Products of Pancreatic Digestion.

As the coagulating point of the albumin in urine varied considerably notwithstanding our efforts to get rid of the effect of urea and neutral salts by dilution, it occurred to us that it would be advisable to ascertain whether the coagulating point of the soluble albuminous substances produced by the action of pancreatic juice upon solid insoluble albuminous bodies varied at different stages of the digestive process. For it is evident that if this should be the

case, and these soluble albuminous bodies should be absorbed into the blood or excreted by the kidneys in the same way as raw white of egg, they would cause the temperature at which coagulation occurred in the urine to vary, apart from any influence of urea, uric acid, or salts, contained in it. The products of pancreatic digestion are in this respect more important than those of gastric digestion, inasmuch as the gastric juice can only act so long as the food continues in the stomach, its power being destroyed by admixture with the bile in the duodenum, while the pancreatic digestion may continue all the way down the intestine, where the greatest facilities for absorption are to be found, much greater than in the stomach. In order to ascertain this point, fibrin obtained from pig's blood was digested with water and some pancreatine (prepared by Messrs. Savory and Moore, and previously ascertained to be active), in a water-bath for about three hours at a temperature of 100°–105° F., until the fibrin had disappeared. The solution thus obtained was filtered, and after standing twenty-four hours, the temperature of coagulation was observed.

Undiluted the solution coagulated at 142°, 138°–142°, 128°–134°, 134°, varying on each separate occasion. The true point appears to be 128°–134° F.

When the solution was diluted with its own bulk of water, coagulation occurred at 136°–140° F. and at 144° F.

The cause of this variability in the coagulating point probably is that during the process of heating more or less digestion of the albumin by the pancreatine occurs, so that the coagulating point is more or less raised in the same way as occurs when the solution stands for a time at ordinary temperatures. When this solution was examined after standing forty-eight hours, indol had been produced to a considerable extent, and the coagulating point of the filtered solution had risen to 168° F.

Another portion of fibrin was digested with pancreatine, and a portion of the solution tested after an hour's digestion in the water-bath. Coagulation occurred at 146°–150° F. A portion was again tested after two hours and fifty minutes' digestion. The coagulating point had fallen to 138°–140° F.

Effect of Urea and Uric Acid on the Coagulation of the Products of Pancreatic Digestion.

The first solution already mentioned, when mixed with its own bulk of water, coagulated at 136°–140°; with its own bulk of 25

per cent. solution of urea, at 160°–165°; with its own bulk of 10 per cent. solution of urea, at 140°–148°; with its own bulk of 5 per cent. solution of urea, at 138°–144°.

When mixed with its own bulk of a saturated solution of uric acid the coagulating point was lowered to 128°–130° F. The second solution, made by digesting fibrin for three hours, only when diluted with its own bulk of water coagulated at 138°–142° F.; with its own bulk of a 5 per cent. urea solution, at 138°–142°; with its own bulk of a half-saturated solution of uric acid, at 130°–134° F. The effect of urea and uric acid upon the coagulating point of the products of pancreatic digestion is thus seen to be similar to that in serum- and egg-albumin. But besides this, we notice that the coagulating point of these products is much lower than that of serum-albumin (about 160° F.). On looking back to the table already given of the temperature of coagulation after diluting, we observe that the numbers in it may be arranged in three groups; the lower ranging from about 130°–137° F., or about the coagulating point of the products of digestion; the upper from about 160°–173° F., or about the coagulating point of serum-albumin; and the other containing intermediate numbers. In the case of Gollop (*vide* p. 396), the coagulating points are seen to belong to the lower, and in that of Hill (*vide* p. 400) to the upper group.

This fact seems to point to the existence of two separate albuminous bodies or classes of bodies in these urines, the albuminous products of digestion and serum-albumin, or a mixture of these. It must be remembered also that although the earlier products of pancreatic digestion coagulate about 130° F., yet after standing the coagulating point rose to 168° F. This corresponds closely with the coagulating point of the albumin in the urine of a patient in whom the appearance of albumin and disturbances of digestion were so closely associated that it seemed probable that the former was in great part at least due to the latter. In this case, which has been already fully described by one of us in another place,[1] the coagulating point was 173° F., and on diluting the urine with its own bulk of water, the coagulating point fell to 171° F.

Effect of Food in causing Albumin to appear in the Urine.

In two cases albumin was observed in the urine after food, while

[1] Arsenic in Albuminuria, by T. Lauder Brunton, M. D. *Practitioner*, June 1877, vol. xviii. p. 427, and *Disorders of Digestion*, p. 322.

EFFECT OF FOOD IN CAUSING ALBUMIN TO APPEAR IN THE URINE.

Name.	Ward.	Disease.	Coagulation begins.	Observation ended.	Time.	Quantity.	Sp. Gr.	Reaction.	REMARKS.	Date.
Glasgow	Henry	Waxy kidney	No coagulation	...	Before dinner	...	1013	Slightly acid	Urine clear and of a normal colour	Sept. 11
			No coagulation	...	,,	...	1005	...		
			148°	152°	After dinner	...	1015	More strongly acid	Urine more turbid ; the coagulation exceedingly slight	...
			No coagulation	...	,,	...	1005	...	The urine became milky	...
Mayhew	Matthew	Dysentery	No coagulation	...	Before dinner	...	1017	Acid	The urine was clear and light-coloured; it was heated to 190° F.	Sept. 18
			No coagulation	...	,,	...	1005	...	No coagulation, even on boiling ; urine diluted	...
			171°	174°	After dinner	...	1022	Slightly acid	Urine clear and light-coloured	...
			No coagulation	...	,,	...	1005	...	No coagulation, even on boiling ; urine diluted	...
			No coagulation	...	Before dinner	...	1029	Acid	Thick chocolate colour, filters clear	...
			176°	...	After dinner	...	1025	Acid		
			No coagulation	...	,,	...	1005	...	Slight turbidity at 176° F.; urine light-coloured and slightly turbid	Sept. 24

it was absent during fasting. In one of these cases its coagulating point was 148°–152°, in the other it was 171°–174°. In both of these urines no coagulation occurred when they were diluted to sp. gr. 1005, and then heated (*vide* table on p. 385).

We here append short notes of Mayhew's case.

Ambrose Mayhew, aged 28, admitted September 12, 1877. He was in India in the army, and was invalided home in April last.

Since October 1876 he has suffered from frequent desire to stool with tenesmus, and almost always passes a little blood. For the first five months he had pain and tenderness in the hepatic region, but never was jaundiced.

Since he was first taken ill he has never got rid of this complaint.

On admission he was much emaciated, but there were no physical signs of disease, except slight tenderness in the region of the liver, which can just be felt below the ribs.

His bowels were opened several times in twenty-four hours; motions scanty, dark, containing a little blood and mucus. He was kept in bed, and put upon milk diet, with 8 grs. of Dover's powder at night, and an occasional small dose of castor oil (2 drachms every second or third day).

At the end of about a week, he was put upon fish, and a few days later was allowed to get up in the evening.

He was discharged on October 24, having improved very much in general health, and gained a little in weight.

His bowels acted about three times a day; the motions were less scanty, always bilious, and containing mucus, but there was no longer any blood.

Effect of Food in Altering the Coagulating Point of the Urine in cases of Albuminuria.

The following tables (pp. 388 and 389), as well as those of the urine of Gollop (p. 396) and Hill (p. 400), show that the urine passed after taking food usually has a lower coagulating point than the total urine passed during the twenty-four hours. This is not, however, invariable, the coagulating point being sometimes raised instead of lowered, as in Gollop's urine of September 19, 21, and 28, and in Hill's of September 15, when coagulation occurred in the urine of the twenty-four hours at 128°–131°, 132°–136°, 136°–140°, and 163°–168°, and in the urine passed after dinner at 134°–136°, 136°–138°, 137°–144°, and 167°–170° respectively.

On the Presence of Peptones in the Urine.

A quantity of urine from Gollop, John Ward, whose case will afterwards be described, was acidulated with acetic acid boiled, thrown upon a filter. A very bulky precipitate of coagulated albuminous substances remained on the filter. To the filtrate alcohol was added in excess, and a copious white flocculent precipitate was thrown down. This precipitate when dried and removed from the filter formed a greyish powder, partially soluble in water, forming a somewhat milky solution. This gave the xanthoprotein reaction. With liquor potassæ and a very slight trace of copper sulphate it gave a faint rose colour. On the addition of a little more copper sulphate it became violet, and the violet deepened on heating. With more still the fluid became blue, the sulphate remaining dissolved. On boiling, a brown precipitate fell, and the fluid remained of a violet colour.

The solution gave no distinct precipitate with mercuric chloride, as peptones usually do.

These reactions appear to us to indicate either the presence of peptones or some other body closely connected with them and not yet investigated, and differing by its non-precipitation by mercuric chloride.

On Digestive Ferments in the Urine in Albuminuria.

It was shown several years ago by Brücke that pepsin was excreted in small quantities in the urine, and the same was observed by Cohnheim in regard to ptyalin. Supposing that by any cause the excretion of these ferments should become abnormally increased, it is probable that the digestive powers might become weakened, and that digestive disturbances such as are observed in albuminuria might result. Now Von Wittich[1] observed that fibrin has a very great attraction for pepsin and absorbs it most energetically. When put into water on one side of the parchment of a dialyser, it causes pepsin to pass through more rapidly from the other side. An excess of fibrin will absorb from artificial gastric juice all the pepsin which has already digested a part of it, and when the undissolved fibrin is taken out and put into fresh acid, the pepsin it contains is generally sufficient to dissolve both it and additional fibrin added

[1] Von Wittich, *Pfluger's Archiv f. Physiol.*, v. 435–469.

Effect of Food in Altering the Coagulating Point of Albumin in Cases of Albuminuria.

Name or No.	Ward.	Disease.	Coagulation begins.	Observation ended.	Time.	Quantity.	Sp. Gr.	Reaction.	Remarks.	Date.
No. 4	Hope	Phthisis albuminuria	169°	172°	Before dinner	...	1025	Acid	Urine clear and of moderate colour	Sept. 20
			174°	178°	,, ,,	...	1005	...		...
			167°	170°	After dinner	...	1023	Acid	Of a darker colour	...
			166°	170°	,, ,,	...	1005	...		...
No. 6	Hope	Chronic Bright	138°	142°	,, ,,	...	1019	Acid	Urine turbid ; light-coloured	Sept. 21
			142°	146°	,, ,,	...	1005	...		...
No. 17	Matthew	Chronic Bright	144°	148°	Before dinner	...	1014	Strongly acid	Light-coloured	Sept. 19
			138°	146°	,, ,,	...	1005	...	The urine became slightly opalescent on diluting	...
			148°	150°	After dinner	...	1016	Very strongly acid	Rather darker than the preceding	...
No. 17	Luke	Chronic Bright	132°	134°	,, ,,	...	1005	...		...
			180°	184°	Before dinner	...	1015	Slightly acid	Urine light-coloured ; somewhat turbid ; had stood for at least twenty-four hours	Sept. 13
			184°	...	,, ,,	...	1005	...		...
			164°	168°	,, ,,	...	1013	Neutral	Light-coloured ; not quite clear	...
			164°	170°	,, ,,	...	1005	...	Coagulation not well marked ; this urine had also been kept at least twenty-four hours	...
			180°	182°	,, ,,	...	1015	Acid	The above urine was tested again after a lapse of twenty-four hours the turbidity had increased, and it had a disagreeable smell	Sept. 14
			182°	186°	,, ,,	...	1005	...	Coagulation not well marked	...
			174°	179°	,, ,,	...	1018	...		Sept. 17
			...	...	,, ,,	...	1005	...	No perceptible coagulation occurred at 190° F.	...
			174°	176°	After dinner	2½ pts.	1012	Slightly acid	Urine clear, and of a very light colour	...
			171°	173°	,, ,,	...	1005	...	In each of the above cases the urine became cloudy at about 158° F., though the coagulation did not begin till a higher point was reached	...

No. 11.	Hope	Chronic Bright	132°	138°	Before dinner	...	1005	...		Sept. 25
			132°	138°	,, ,,	...	1005	...		
			126°	128°	After dinner	...	1015	Acid	Became opalescent on diluting. *Cf.* John, No. 8	...
			136°	...	Before dinner	...	1016	Acid	The red colour disappears when the litmus paper dries. On diluting, the fluid becomes so milky that the coagulating point cannot be observed. The after-dinner urine is very thick; the thickness is not diminished by filtering	...
			120°	124°	After dinner	...	1015	Acid	... ...	Sept. 26
			110°–116°	120°	,, ,,	...	...	...	A slight coagulation occurred at 100° F., more at 131°-148°; a copious precipitate at 152°, and at a higher point the precipitate was flaky	Sept. 27
			110°	115°	Before dinner	...	1015	Acid	The urine was light-coloured and turbid. At 188° F. the after-dinner urine became flaky. On diluting it was at first clear, but after standing a minute it became opalescent. On standing, the coagulated precipitates sank to the bottom, leaving a clear supernatant fluid	...
			128°	151°	After dinner	...	1016	Very acid	Excess of Na_2So_4 was added, and the mixture was boiled; the coagulated albumin was filtered off, and the filtrate was tested by the Xanthoproteic reaction for peptones; none however were found	...
			160°	166°	,, ,,	...	...	Acid		
			150°	154°	,, ,,	...	1005	...	This urine contained casts; it was very turbid and of a brown colour; after filtering it became clear, and was then seen dark-coloured. The coagulation was exceedingly well marked, beginning at the surface at 160° F., and extending slowly to the bottom, which was reached at 166° F.	Oct. 3

to it, while the liquid from which it has been removed has lost all peptic properties. In these experiments it is to the undissolved fibrin that the pepsin adheres, and not to the dissolved products of digestion, yet it seemed not impossible that albuminous bodies in their passage through the kidney might take along with them more of the digestive ferments than usually pass out of the body in the urine, and we therefore made the following experiments in order to ascertain the presence in the urine of pepsin and ptyalin, as described by Brücke and Cohnheim, and also to see whether other ferments, such as those of the pancreas and intestine, which are not usually present in the urine, occurred in albuminuria.

On the Presence of Pepsin.

Ten fluid ounces of urine from a case of chronic Bright's disease were mixed with twenty-eight ounces of strong methylated spirit. A copious precipitate of proteids occurred. After standing for two days the supernatant fluid was washed, decanted off, and the precipitate washed with absolute alcohol. The alcohol was then filtered off, and the precipitate immersed in glycerine, where it remained six days. It was then filtered, and the clear filtrate used for experiments.

To 10 c.c. of this clear glycerine extract 25 c.c. of a ·02 per cent. solution of hydrochloric acid was added, and a piece of boiled fibrin put into the solution. It was then kept for twenty-four hours in a water-bath at a temperature of 100° F., and the liquid tested for albuminous bodies in order to see whether any of the fibrin had been dissolved. A similar experiment was also made using raw instead of boiled fibrin. In order to make certain that any digestion which might be observed was due to something removed by the glycerine from the urinary precipitate, and not to the glycerine alone, or to the acid, control experiments were also made with pure glycerine instead of the glycerine extract. The results of these experiments were chiefly negative, but were not sufficiently definite to prove either the absence or presence of pepsin.

On the Presence of Diastatic Ferments (Ptyalin or Pancreatic).

To 100 grains of starch mucilage 10 grains of glycerine extract of albuminous precipitate from urine were added, and the mixture

was digested for ten minutes in a water-bath at 100° F. After removal the fluid was divided into two parts. To A, tincture of iodine was added; there was no change of colour. To B, freshly-made Fehling's solution was added, and the mixture boiled; no change occurred immediately, but on standing a minute or two, *a slight greenish-yellow colour appeared.*

In a control experiment made with glycerine only and starch paste in the same proportions, iodine *gave a slight trace of blue;* whilst after boiling with Fehling, *no* change was observed.

The above experiments were repeated after twenty minutes' digestion; *a fair amount of sugar* was shown to be present by Fehling's test, whilst in the control experiment *no trace* of sugar was found.

On the Presence of Pancreatic Ferment (Trypsin).

The following experiment seems to show the presence of this ferment in the urine, although in small quantity, so that although raw fibrin was slightly attacked, traces of albumin being apparent in the solution, boiled fibrin was not dissolved at all.

To 10 grains of the glycerine extract 100 grains of a 1 per cent. solution of sodium carbonate was added, and the whole was digested with a piece of boiled fibrin for 18 hours at 80° F.

The fluid was tested (*a*) by boiling—there was *no* precipitate; (*b*) by adding nitric acid and boiling—there was *no* precipitate; (*c*) by neutralising with acetic acid—there was *no* precipitate.

The above experiment was repeated as a control experiment with glycerine. No evidence of pancreatic digestion was obtained.

The digestion was made in presence of *raw fibrin,* and the liquid was tested (*a*) by boiling—there was *no* precipitate; (*b*) by adding HNO_3—a *turbidity was produced* which did not disappear on boiling; (*c*) on neutralising with acetic acid, *a very slight turbidity was perceptible.*

The experiment was repeated with plain glycerine as a control, and the result was tested as before; *no* evidence of any digestion was obtained.

On the Presence of Intestinal Ferment converting Cane into Grape Sugar.

The following experiment is not conclusive, but rather tends to show that such a ferment is present in the urine.

September 29.—A solution of pounded white sugar was made, of which 200 grains were added to 20 grains of extract. After 40 minutes' immersion in the water-bath at 90° F., the liquid was tested with Fehling's solution; *a slight change* of colour was observed.

To 200 grains of sugar solution 20 grains of glycerine were added, and after 40 minutes' immersion in the water-bath, was tested by boiling with Fehling's solution; a slight change of colour occurred, not so much, however, as in the preceding case.

When the glycerine only was boiled with Fehling, a slight change of colour, equal to that which occurred in the preceding experiment, took place.

On Sugar and Glycogen in the Urine.

It was noticed that this urine in Gollop's case became milky when diluted with water. At first we thought this was due to fat or oil, but on mixing it with ether, removing the ether and allowing it to evaporate, no grease spot was obtained, showing the absence of fat. The milkiness was so great that the diluted urine resembled very closely the liquid obtained by boiling a fresh liver in the preparation of glycogen. The presence of glycogen was therefore sought for, and at first we thought we had found it in quantity, but further experiment showed we were mistaken. On acidulating the urine slightly with acetic acid and boiling, a very large precipitate of coagulated albumin fell. This was separated by filtration, and alcohol in excess added to the filtrate. This threw down a copious white flocculent precipitate closely resembling glycogen. When collected on a filter and dried, and removed from the filter, it formed a grey powder. This was partially soluble in water, and formed a slightly milky solution. On testing it, however, with tincture of iodine, no red colour appeared. In a little diluted urine to which glycogen had been added, the red colour appeared, although only for a moment and then disappeared. On boiling the solution of the white powder in water with sulphuric acid, and then neutralising and testing for sugar, no positive evidence of its presence was obtained. The same was the case when the solution of the powder was heated for some minutes at a gentle warmth with glycerine extract of pancreas. On testing the diluted urine in the same way, sugar was found; but on testing another specimen of the urine without treating it

either by acids or pancreas, sugar was also found. The quantity of sugar after treatment seemed to be somewhat greater than before, but it was not sufficiently so to enable us to decide positively that the sugar had been increased. From these reactions it appears that the urine in Gollop's case contained sugar as well as albumin, and that possibly, but by no means certainly, a small quantity of glycogen was also present in it.

On Albuminous Substances derived from the Blood which are present in the Urine in Albuminuria.

In the preceding part of our paper we have dealt with albuminous substances absorbed from the digestive tract and excreted by the kidneys in much the same way as urea. The occurrence of these in the urine we regard as due to imperfect performance of the functions of the digestive tract rather than of those of the kidney. But it is impossible to remove albuminuria entirely from the connection it has hitherto had with diseases of the kidney, and class it like diabetes, which formerly occupied a similar position amongst diseases of assimilation. For even if we leave out of account the changes in the structure of the organ which produce albuminuria, but which take some time to produce, and might therefore be associated with alterations in digestion, we know that ligature of the renal veins will in a few minutes produce albuminuria, although the intestine has not been interfered with, or at least to such a slight extent that it would not have produced albuminuria had the ligature been merely passed around and not tightened upon the renal vessels.

The albuminous bodies which usually pass from the blood into the urine are serum-albumin and paraglobulin. Serum-albumin, as has been already mentioned, is soluble in water; paraglobulin is not soluble in pure water, but it is soluble in water containing a small quantity of NaCl, or containing much oxygen. It is precipitated from dilute solutions by carbonic acid, and is redissolved if the water be shaken up long enough to allow it to take up oxygen and let the carbonic acid escape. Both serum-albumin and paraglobulin have been found in the urine by Edlefsen and Senator. In one case of chronic Bright's disease, that of Gollop, we have already stated that the urine in this case became so milky on dilution that we at first thought the milkiness due to glycogen. But as we have shown already, the presence of glycogen

was doubtful, and if present, its quantity was too small to account for the milkiness, for which we were therefore obliged to seek another cause.

Several peculiarities in regard to this milkiness were also noted. It appeared when the urine was diluted with distilled water or with warm water, but not when water fresh from the tap was used. This at once seemed to point to paraglobulin, which is soluble in water containing oxygen. Thus the water fresh from the tap might dissolve it, while water from which the air had been expelled by boiling would not.

The following reactions tended to confirm the conclusion that paraglobulin was the cause of the milkiness. Acetic acid caused the milkiness to disappear. Acetic acid with ferrocyanide of potassium caused a precipitate. These reactions show that the turbidity was not due to mucin. The milkiness also disappeared on the addition of a 2 per cent. solution of NaCl, of dilute hydrochloric acid, of ammonia, or of caustic potash.

On passing a stream of CO_2 through the diluted urine, the milkiness became much greater, and a white flocculent precipitate appeared in considerable quantity, separating very slowly from the liquid. On filtration a nearly clear liquid was obtained. This began to get turbid when heated to 140° F., but between 160° and 165° the turbidity rapidly increased, and a flocculent precipitate (paraglobulin) separated. On filtering this, and adding its own bulk of absolute alcohol to the filtrate, a slight but distinct milkiness appeared and gradually increased. This is probably due to the presence of peptones.

On the Coagulating Point of the Urine in Different Diseases.

A comparison of the tables given already under the head of the effect of food on the coagulating point, as well as of the two following ones in the cases of Gollop and Hill, will show that the coagulating point will not infallibly indicate the nature of the disease; yet the great differences between the urine of the two following cases, the one of waxy kidney, in which the coagulating point was about 162° F., and the other of chronic Bright's disease, in which the coagulating point was about 132° F., cannot be regarded as unimportant.

George Gollop, aged 27, chairmaker, admitted to John Ward under Dr. Church, August 30, 1877.

August 30.—Pale face, watery conjunctivæ. Œdema of lower limbs and scrotum; some ascites. Pulse, 80; rather hard. Heart sounds normal. Some impairment of resonance and feeble breathing at bases of both lungs. Urine pale; acid; white deposit, specific gravity, 1020; highly albuminous. The deposit was several times examined microscopically, and found to consist chiefly of loose renal epithelium, occasionally with casts, hyaline, granular, or epithelial.

Had scarlet-fever when quite young; smallpox (?) six years ago. Since that time has had a cough. Legs began to swell last January; abdomen about six weeks ago.

Put on D. L. and milk. Confect. jalapæ, ʒi. o. m.; Tr. ferri perchlor., m. xv.; glycerini, m. x.; aq. menth. pip., ℥i. 6tis.

September 1.—Urine has ranged from $1\frac{3}{4}$ to 2 pints. Œdema and ascites increasing. Meat makes him sick.

Put on D. L., fish, two eggs. Hst. scoparii co., ter.

September 13.—Urine has averaged 2 pints. Is no better.

Ordered Pot. acetat., gr. xx.; sp. æth. nit., ʒss.; tr. digitalis, m. xv.; ex. hst. scoparii co., ter.

October 6.—Has complained much of thirst. Cough is getting worse.

Resinæ copaibæ, gr. x., ter.

October 11.—Urine has reached nearly 3 pints per diem, but the œdema remains.

Pot. acetat., gr. xv.; sp. juniperi, ʒi.; inf. digitalis, ℥ss.; hst. a. a. c̄. scilla ad., ℥i. 6tis. Chop or fish according to fancy.

October 24.—Urine has averaged 2 pints. Dyspnœa increasing.

Medicine to be discontinued, and the constant current to be applied daily, one rheophore to the lumbar region, the other to the front of the abdomen.

November 10.—Electrical treatment to be discontinued; it has produced no diuresis. The œdema, anasarca, and dyspnœa have been worse.

Lately he has had pulv. jaborandi, gr. xxv. o. n., but no effect can be certainly traced to it.

November 12.—Convulsive fit.

November 17.—Is still under treatment.

Henry Hill, aged 16, admitted to John Ward under Dr. Church, August 2, 1877.

August 2.—Small, pale, and ill-nourished. Tongue clean and

TABLE SHOWING THE CONDITION OF THE URINE IN THE CASE NARRATED ON PAGE 395.

Name or No.	Ward.	Disease.	Coagulation begins.	Observation ended.	Time.	Quantity.	Sp. Gr.	Reaction.	REMARKS.	Date.
Gollop No. 8	John	Chronic Bright's disease.	131°	140°	24 hours' urine	1¾ pts.	1019	Strongly acid	The urine was of a pale straw colour, and was turbid	Sept. 5
			132°	137°	24 hours	...	1005	...	The urine was diluted with distilled water to 1005	...
			124°	126°	24 hours	Nearly 2 pts.	1020	Strongly acid	The urine was of a pale straw colour, and was turbid throughout, except when otherwise stated	Sept. 7
			130°	135°	24 hours	...	1005	...	On diluting, the urine so milky that it was difficult to observe the coagulating point	...
			128°	132°	Before dinner	...	1021	Acid	Fairly clear; thick white sediment	Sept. 8
			132°	132°	Before dinner	...	1005	...	Became opalescent on diluting (not due to fat or mucin) globulin (?)	...
			130°	134°	24 hours	2 pts.	1019	Acid		
			128°	133°	24 hours	Over 2 pts.	1021	Acid	...	Sept. 10
			127°	128°	After dinner	...	1024	Acid	Coagulated remarkably quickly; it had, I believe, been standing for 24 hours.	Sept. 11
			131°	134°	24 hours	2 pts.	1019	Slightly acid		
			136°	136°	24 hours	...	1005	...	At 136° it had coagulated	...
			128°	134°	24 hours	Nearly 2 pts.	1021·5	Strongly acid	So thick as to require filtering	...
			...	...	24 hours	...	1005	...	The coagulation was marked by the opalescence	Sept. 13
			...	...	After dinner	...	1025	Acid	Fairly clear	...
			135°	...	After dinner	...	1005	...	The coagulating point is approximate only	...
			131°	132°	24 hours	2 pts.	1022·5	Acid	Slightly turbid; remarkably rapid and well-defined coagulation	Sept. 14
			136°	140°	24 hours	Over 2 pts.	1022	Acid	The urine was filtered before warming	Sept. 15
			130°	132°	After dinner	...	1025	...	Prompt coagulation	...
			128°	136°	24 hours	Over 2 pts.	1024	Acid	The urine required filtering	Sept. 17
			132°	136°	After dinner	...	1024	...	On diluting, the urine as before became opalescent	Sept. 18
			134°	138°	24 hours	2·25 pts.	1022	Acid	... ...	Sept. 18
			134°	136°	After dinner	...	1013	Acid	... ...	Sept. 19
			128°	131°	24 hours	2·25 pts.	1022	Acid	Slightly turbid; becomes opalescent on diluting	

			136°	138°	After dinner	...	1023	Acid	Clear and light-coloured urine; coagulates very distinctly	Sept. 20
			138°	140°	24 hours	2¼ pts.	1021	Acid	The urine is rather turbid, and was not tested after dilution as it was opalescent	...
			136°	138°	After dinner	...	1025	Acid	Clear and light-coloured; of an oily consistency	Sept. 21
			132°	136°	24 hours	2 pts.	1025	Acid	Slightly thick	...
			132°	138°	After dinner	...	1025	Slightly acid	Fairly clear	Sept. 22
			134°	138°	24 hours	1·5 pts.	1025	Slightly acid	Rather turbid; opalescence well marked on diluting	...
			136°	139°	After dinner	...	1024	Acid	...	Sept. 24
			136°	140°	24 hours	2 pts.	1023	Acid	Rather thick	...
			134°	136°	After dinner	...	1025	Acid	The colour was somewhat darker than usual	Sept. 25
			132°	135°	24 hours	1·75 pts.	1023	Acid	Rather thick; became as usual opalescent on dilution *Cf.* No. 11 Hope Ward	...
			144°	138°	After dinner	...	1024	Acid	The urine was quite clear, with a thick sediment	Sept. 26
			131°	138°	24 hours	2 pts.	1024	Acid	Rather thick	...
			131°	133°	24 hours	Over 2 pts.	1025	Acid	Rather darker in colour than usual; became opalescent on diluting	Sept. 27
			137°	144°	After dinner	...	1024	Acid	Urine clear	Sept. 28
			136°	140°	24 hours	1·5 pts.	1024	Acid	Slightly turbid; very opalescent on diluting	...
			132°	137°	24 hours	1½ pts.	1024	Acid	Very slightly turbid; opalescent on diluting	Sept. 29
			135°	139°	24 hours	Nearly 2 pts.	1021	Acid	Turbid with viscid masses at bottom of vessel; rather dark-coloured	Oct. 1
			132°	138°	24 hours	Over 2 pts.	1022	Acid	Very thick, and of a somewhat dark colour	Oct. 2
			130°	135°	24 hours	2 pts.	1020	Acid	Turbid	Oct. 3
			131°	138°	24 hours	1 pt.	1022	Acid	Light-coloured; turbid	Oct. 5
			128°	136°	24 hours	2½ pts.	1018	Acid	Light-coloured; rather turbid	Oct. 6
			132°	138	24 hours	2¼ pts.	1020	Acid	Dark-coloured; turbid	Oct. 8
			136°	144	24 hours	1½ pts.	1014	Acid	Darker coloured; turbid; the observation was made in the laboratory, with the laboratory urinometer	Oct. 9
			130°	140°	24 hours	Over 2 pts.	1018	Slightly acid	Lighter coloured; turbid; the experiment made with laboratory instruments	Oct. 10
			132°	138°	24 hours	2¼ pts.	1020	Acid	Light-coloured; slightly orange tint; very turbid	Oct. 11
			132°	138°	24 hours	...	1020	Acid	Darker coloured; turbid	Oct. 12
			128°	134°	After dinner	...	1020	Acid	Rather light in colour; turbid	...

red. Pulse small, 100. General prominence of lower cervical, and sharp projection of lower dorsal vertebræ. A discharging sore in either groin. Abdomen very large, containing fluid. Liver enlarged to within 3 inches of umbilicus; firm, smooth, with sharp edge. Urine amber-coloured; clear; specific gravity, 1015 to 1020; moderately albuminous. Feet and legs œdematous. No loss of motor power in legs.

Has had curvature of spine six years, abscesses in groins three years, swelling of legs and abdomen two months.

Ordered D. L., milk, Oj.

August 8.—Diarrhœa, which he ascribes to the milk.

Allowed a pint of ale instead, and given bismuth, subnitr., gr. x.; pulv. tragacanth co., gr. xv.; ex. hst. cretæ aromat., 6tis.

August 10.—Diarrhœa varies.

Diet altered to beef-tea, arrowroot, pudding, egg i., soda-water, ij., brandy, ℥ij.; given pulv. kino co., gr. x.; o. n.

August 16.—Diarrhœa better.

Chop and an extra ounce of brandy added to diet. To stop the kino powder, and to take acid. sulph. aromat., m. xx.; tr. opii, m. iv.; sp. chloroform, m. x.; decoct. hæmatoxyl., ℥i. ter.

August 20.—Very fanciful about his food. Put on extras.

September 3.—Dyspnœa, and pain over liver, with increase of ascites, have been gradually coming on, and have reduced him to an extremely feeble state. Paracentesis performed; 16 pints or more of clear ascitic fluid withdrawn, to his great relief.

September 6.—Abdominal pain. Cannot sleep without tr. opii, m. x.; o. n.

Medicine of August 8 repeated.

September 17.—Paracentesis had to be performed again.

September 22.—Died.

At the *post-mortem*, the liver, kidneys, and spleen were enlarged and amyloid; the intestines and stomach also stained with iodine; there was a psoas abscess on either side; but no active disease of the vertebræ.

General Results.

The general results at which we have arrived from the observations detailed in this paper are:—That there are various albuminous bodies which appear in the urine. Some of these are derived from the digestive canal, and others from the blood, of

which they form ordinary constituents. Those derived from the digestive canal may be either albuminous substances absorbed without undergoing digestion, as, for example, the white of raw eggs, soluble albuminous substances produced from coagulated albuminous bodies by incomplete digestion, or peptones. Those albuminous bodies which form constituents of the blood, and which we have noticed in the urine, are paraglobulin and serum-albumin. The former is in comparatively small quantity, the latter forming the great bulk of the albumin in ordinary albuminuria. Glycogen was only doubtfully present. The co-existence of sugar and albumin, which we noticed in one case,[1] is interesting, as Bernard found that while puncture of one point in the fourth ventricle caused sugar to appear in the urine, puncture of an adjoining point caused albumin to appear; and Pavy succeeded by one puncture in causing them both to appear together. The effect of food is to increase the quantity of albumin in the urine, or even make it appear when it is absent during fasting. Its effect on the coagulating point is not constant, although it generally lowers it. This may be due to the fact, which we have observed, that while the earlier products of the pancreative digestion of fibrin have a lower coagulating point, the later products have one which is higher than that of serum-albumin. In connection with this point it is interesting to notice that while pepsin occurs normally in the urine, we failed to find it, possibly because we operated on too small a quantity, and nevertheless we obtained evidence of the presence of pancreative ferment (trypsin). This is the first case we know in which this ferment has been found in the urine, and its loss in unusual quantity may possibly prove injurious to digestion, and be one cause why the albuminous products of imperfect digestion appear in the urine. Further observations are wanted, but this would seem to point to the existence of a vicious circle in this, as in other diseases, the albuminuria leading to the excretion of pancreatic ferment, and the loss of pancreatic ferment leading to imperfect digestion with excretion and loss of its soluble albuminous products. In a case recorded by one of us elsewhere, pancreatine was found to lessen the albumin, or even remove it entirely from the urine.[2] We also found a diastatic ferment which might either be ptyalin, already found by Cohnheim in normal urine, or the diastatic ferment of the pancreas. Intestinal ferment

[1] That of Gollop.

[2] Arsenic in Albuminuria, by T. Lauder Brunton. *Practitioner*, June 1877.

TABLE SHOWING THE CONDITION OF THE URINE IN THE CASE OF HILL, PAGE 398.

Name or No.	Ward.	Disease.	Coagulation begins.	Observation ended.	Time.	Quantity.	Sp. Gr.	Reaction.	REMARKS.	Date.
Henry Hill No. 3	John	Waxy kidney	164°	170°	24 hours	½ pt.	1016	Neutral or slightly acid	The urine was strong-smelling, dark-coloured, thick, and ropy	Sept. 5
			164°	170°	...	...	1005	...	The urine was diluted with distilled water	
			158°	164°	24 hours	...	1014	Acid	The urine continues to be dark-coloured, but is less viscid, and is pretty clear	Sept. 7
			160°	160°	...	...	1005	...		
			160°	166°	Before dinner	...	1015	Acid	Dark-coloured, containing blood clots; thick, and slightly viscid	Sept. 8
			166°	172°–174°	...	...	1005	...		
			164°	...	24 hours	Over ½ pt.	1014	Acid	Still viscid	
			166°	170°	...	...	1005	...	Coagulation not particularly well marked	
			162°	168°	24 hours	¾ pt.	1014·5	Acid	Less ropy	
			152°	166°	...	...	1005	...		Sept. 10
			168°	170°	10 hrs. after food	...	1019·5	Acid	The next passed after dinner; dark-coloured; not ropy; coagulation distinct; had stood 16 hours	Sept. 11
			166°	172°	10 hrs. after food	...	1005	...		
			162°	168°	24 hours	½ pt.	1017·5	Acid		
			161°	165°	24 hours	...	1005	...		
			168°	171°	24 hours	1¼ pts.	1014	Acid	Slightly turbid; coagulation apparently began at 162°, but was not decided	Sept. 13
			164°–169°	174°	24 hours	...	1005	...		
			162°	168°	After dinner	...	1015	Acid		
			164°	...	After dinner	...	1005	...		
			163°	168°	24 hours	Over 1 pt.	1012	Acid		
			162°	164°	24 hours	...	1005	...	... ...	Sept. 14
			163°	168°	24 hours	...	1015	Acid	Turbid, with visible particles suspended in the fluid	Sept. 15
			162°	166°	24 hours	...	1005	...		
			167°	170°	After dinner	...	1014	Acid		
			171°	173°	After dinner	...	1005	...		

			158°–166°	170°	24 hours	Over 1 pt.	1015	Acid	Tolerably clear; the main coagulation occurred at 166°–170°	Sept. 17
			164°–166°	171°	24 hours	...	1005	...		
			161°	171°	...	...	...	Alkaline	Fluid obtained by tapping; was of a light yellow colour, and of a thick consistency	Sept. 18
			169°	172°	...	...	...	...	The fluid was diluted with its own bulk of distilled water	
			156°	160°	After dinner	...	1017	Acid	The boy was tapped at 4·30 P.M. on the 17th; examination of fluid was made at 2·30 P.M.	
			158°	162°	After dinner	...	1005	...	The urine was thick and very dark-coloured; it was filtered	
			152°–158°	162°	24 hours	Under $\frac{1}{2}$ pt.	1016	Acid	The urine on diluting became slightly opalescent, as in No. 8 case	
			156°	161°	24 hours	...	1005	...	Urine dark-coloured	
			158°	164°	After dinner	...	...	Acid	Not sufficient to take sp. gr.; very thick, but cleared on warming; filtered	Sept. 19
			153°	156°	After dinner	...	1005	...		
			154°	160°	24 hours	$\frac{1}{4}$ pt.	1017	Acid	Urine clear, and not so dark-coloured as usual	
			159°	164°	24 hours	...	1005	...		
			160°	164°	After dinner	...	1014·5	Acid	Urine clear and dark-coloured	Sept. 20
			162°	168°	After dinner	...	1005	...		
			162°	166°	24 hours	$\frac{1}{8}$ pt.	1015	Acid		
			154°	...	24 hours	...	1005	...	Coagulation was very indistinct, but was probably about 154° F.	
			162°	168°	After dinner	...	1013	Acid	Much lighter coloured, and nearly clear	Sept. 21
			164°	...	After dinner	...	1005	...	Coagulation not well marked, but continues onwards from 164° F. As the boy died, the urine for 24 hours was not obtained. No decided coagulation even at 182° F.; urine dark-coloured; coagulation not perceptible at 182° F.	Sept. 22

In these tables "24 hours" means the collected urine passed during twenty-four hours.

converting cane into grape sugar was doubtfully present in the urine.

It is certain that albuminuria cannot be removed, like diabetes, from its place amongst diseases of the kidney to be classed entirely with diseases of assimilation, but probably some cases are almost or entirely due to disordered assimilation, and also in those cases where the kidney is undoubtedly diseased, the loss of albumin is increased by disordered assimilation. Attention to this point in the pathology of the disease will of course have an important bearing on treatment, and while the effects of remedies as tried in a case of confirmed Bright's disease, such as Gollop's, have been hitherto unsatisfactory, it may yet be possible, under the guidance of a more correct pathology, to attain to more efficient measures of cure. The coagulating point of albumin in urine may be readily ascertained without trouble at the bedside. The indications which it gives are not decisive as to the nature of the disease, but more extended observations than we have been able to make may, and probably will, yield much information useful both in prognosis and treatment.

ON CERTAIN POINTS IN THE PATHOLOGY AND TREATMENT OF INDIGESTION.

Read before the Lancashire and Cheshire Branch of the British Medical Association.

(Reprinted from the *British Medical Journal,* Jan. 8, 1881, p. 41.)

THE subject of indigestion is so very wide, that I cannot take up more than one or two points connected with it in the present paper. There are few subjects in medicine of greater practical importance; for there are few that come more frequently under the notice of the medical man, that cause greater annoyance to the patient, or are more satisfactory to treat—at all events, in the earlier stages. I have no doubt that many things which I may say in this paper will be quite familiar to you all; and what I hope to do is not so much to give you new observations on the symptoms of indigestion, or new methods of treatment, as to discuss the causes of the symptoms and the results of the treatment in such a way as, perhaps, to render the treatment more systematic.

By digestion we mean the solution and absorption of the food, and the rejection of the excreta, in such a way as properly to nourish the body; and by indigestion we understand the non-solution or malassimilation of the food, and the imperfect removal of its waste products. Digestion begins in the mouth; and, if we retain farinaceous food in the mouth for a sufficiently long time, the starch will be converted into soluble sugar, and will be dissolved. But it is rare for us to allow the food to remain in our mouths long enough for any solution to take place, excepting in the cases of such very soluble substances as salt or sugar. The saliva, which is secreted by the mouth, performs most of its solvent action in the stomach, after it has been swallowed. We might, therefore, look upon the stomach, and not the mouth, as the first part of the intestinal canal where digestion takes place. But if digestion begins in the stomach, indigestion very often begins in the mouth; for it is in the latter that one of the most important

parts of the solvent process takes place—namely, that of mastication. The digestive juices act but very slowly upon large masses either of starch or of albuminous food, though they will attack those substances readily if they are completely broken up. Most of us, I dare say, remember from our boyish days how long a bull's eye of sugar takes to dissolve in the mouth, so long as it remains whole; and how quickly it disappeared after we had once yielded to the temptation to crush it between our teeth. And what is true of sugar is also true of bread and of meat.

Why should bread fresh from the oven be indigestible, and the same bread, after it has become stale, perfectly wholesome? I think you will readily see the reason by crushing a piece of each between your fingers. You will find that the new bread simply forms a toughish mass, while the stale crumbles into a fine powder. Dip a piece of each into water, and the new bread will only take up a little, while the stale sucks it up like a sponge. These two properties of the stale bread—its ready pulverisation and its sponge-like absorptive power—render it easily broken up and easily saturated by the digestive juices, so that it is quickly and conveniently digested; while the new bread is liable to form, in the stomach and intestines, pieces which are not readily permeated by these juices, and are, therefore, dissolved with comparative slowness. The same thing is the case with meat. When it is taken into the stomach in large lumps, the gastric juice can attack it only on the outside; but, when it is thoroughly broken up by the process of mastication, it is dissolved with great facility.

We see the advantage of a fine subdivision of food in the case of milk, which in the stomach is curdled into small flakes, which are digested with great rapidity. These fine flakes are seen in healthy infants, who regurgitate some of their food after having taken too much. But, in children whose stomachs are out of order, the milk curdles in a different way, is thrown down in large indigestible lumps, which are either vomited up, or pass into the bowels, causing diarrhœa. In such cases, we mix the milk with lime-water, which causes the casein to be again thrown down in small flakes, and thus prevents a repetition of the mischief.

Now, imperfect mastication is a very common condition, and is the source of a great deal of the dyspepsia with which we meet. It may have several causes. Decayed teeth are one cause. Even when, on cursory examination, the teeth appear to be fairly sound, a small spot of caries on one of them will make it tender, and its

possessor uses the other side of the mouth almost entirely for mastication. If there be tender teeth on both sides, he is tempted to bolt his food after masticating it very imperfectly. Want of teeth is another cause. We sometimes see patients whose teeth, so far as they possess them, are either decayed, or, more generally, carefully stopped, but who have large blanks in either jaw, whence the molars which formerly filled them have been removed. Those molars which remain are sometimes rendered almost useless from the want of opposing molars in the other jaw, and thus the food is very imperfectly broken up. Another cause, and perhaps a still more frequent one, is the habit of eating hastily, without taking time to masticate. This is not unfrequently induced, in the present day, by the necessity of catching a train shortly after a meal, or by swallowing the food during too brief an interval from business. Another cause is the habit of reading about, or thinking of, during meals, such subjects as relate to one's daily actions. So long as a man reads about something which has no direct reference to his own activity, I do not think it does him much harm; but, if his thoughts be directed towards anything which concerns his active life, the case is very different. I have observed that, in such circumstances, the mere thought of an exertion which he must make at some future time seems to lead to hurry in the present; and so the man bolts his food, finishes his meal in double-quick time, and hastily rises from the table. All this causes imperfect mastication of the food, and consequently leads to its imperfect solution in the stomach and intestines, or, in other words, to indigestion. So long as the man is young, the effects of imperfect mastication may not be noticed, because almost all the organs of his body are capable of doing more work than they are usually called upon to perform, just as he himself is rarely worked up to his full powers. A young man, even if pretty hardly worked, is almost always ready for a spurt when called upon; and so are his stomach, heart, or lungs. But, as life advances, he becomes less and less ready for a spurt. He is living more and more up to the limit of his powers; and the same is the case with his stomach and intestines. The young man's stomach will digest his food even when imperfectly masticated; but, as middle age approaches, this becomes more impracticable; and, unless the food be previously broken up, the gastric juice is powerless to dissolve it. The symptoms which then occur are much the same as those which would be produced by deficient

secretion of gastric juice in the stomach; and, in all cases of indigestion, the first thing we should do is to examine the teeth, and make inquiry as to the length of time devoted to meals; and it is well, if possible, to get some information on this point from others than the patient, as he may be unconscious of his habit. If we find that the patient is in the habit of bolting his food, we must insist on more time being taken, and advise him to give his thoughts to his food, and not to his business, while he is taking his meals.

Where we find the teeth imperfect, of course the patient should be sent to a dentist, either to have the decayed teeth properly stopped, when that is practicable; or extracted, when stopping is impossible, and to have the blank spaces left by removal filled up by artificial teeth—so that mastication may be rendered easy. But, even when mastication is thoroughly performed, we find that indigestion may occur from various conditions of the stomach itself. One of the most common of these is catarrh, whether acute or chronic. The symptoms to which this condition gives rise are usually loss of appetite, with an occasional tendency to nausea. Sometimes, however, there is increased appetite, or a gnawing sensation before meals, disappearing as soon as food has been placed on the table, or the first mouthful has been swallowed, and giving place to anorexia. There is a feeling of weight at the epigastrium, and very often pain after meals there, shooting through between the scapulæ. There is much flatulent distension, and sometimes eructation. It is interesting to trace the symptoms to these causes in functional or structural changes in the condition of the viscera, though sometimes our attempts are very imperfect, and occasionally entirely unsuccessful. The loss of appetite in these cases may, however, be connected with a certain amount of congestion—as may also the increased appetite: for, although the cause of appetite has not been precisely made out, it appears, to some extent at least, to be associated with a full condition of the vessels in the stomach. Thus it is that so many different drugs have the power of increasing appetite. Bitters, such as quassia and quinine; stimulants, such as brandy and whisky; irritants, such as red capsicum and arsenic, all have this power. Perhaps the one point in which they agree is, that they all tend to cause congestion of the sensitive mucous membrane. But, when the irritation passes beyond a certain point, a change takes place; and, instead of appetite being felt, there is a sensation of nausea. All the drugs

that I have mentioned have this effect, when given in too large quantities. Though in small doses they cause appetite, in large ones they excite nausea or vomiting. We might expect, then, that a moderate degree of congestion, due to a catarrhal condition, would excite in the stomach a feeling of appetite akin to that produced by irritant drugs; and that, when the congestion was still more increased by the stimulating effect of the first few morsels of food, the feeling of appetite would be replaced by one of satiety or nausea. The cause of the feeling of weight at the epigastrium we cannot precisely determine; but I should be inclined to think it due to the continued pressure of the weight of food upon one part. In the healthy stomach, the peristaltic movements of its walls keep the food in constant motion, and thus its weight is distributed through the entire viscus, and not allowed to press long upon any one part of it. We all know that a slight weight, when allowed constantly to press upon one part, becomes painful, or almost unbearable—though, if moved about over different parts of the body, it would produce a sensation rather agreeable than otherwise. The feeling of weight and dragging at the epigastrium, then, I am inclined to associate with impaired movements of the stomach, allowing the food to accumulate in the greater curvature; and, by its constant pressure upon that part of the organ, and continued dragging upon the pyloric and cardiac extremities, producing the feeling of weight as well as the shooting pain between the scapulæ already spoken of. The flatulent distension is probably partly owing to the generation of gas during the slow and imperfect digestion of the food in the stomach; and partly also to its slower absorption by the blood: for there can, I think, be little doubt that an interchange of gas takes place between the gases in the stomach and the blood in the gastric vessels, just as an interchange occurs between the air in the lungs and the blood in the pulmonary vessels. It is, no doubt, much slower in the stomach, even under healthy conditions; because the layer of tissue lying between the vessels and the gas is much thicker in the stomach than in the lungs. In a catarrhal condition, the difficulty of absorption would be increased in two ways; because not only will the layer of mucus lying in the stomach oppose a considerable impediment to the absorption of gas, and thus take up the gas more imperfectly, but the blood in the congested vessels will circulate more slowly. In cases of heart-disease, we very often find that the patient is a good deal

troubled by flatulence, which may, no doubt, partly depend on catarrhal changes in the stomach itself, due to the impeded circulation; but is, in my opinion, also in part due to the slow circulation itself. For one can notice that flatulence is very apt to come on in a healthy person, when the circulation is embarrassed after running to a train. Nor is the heart the only organ which leads to congestion of the stomach. In mitral-disease, no doubt, the backward pressure of the blood upon the stomach through the portal veins, which are destitute of valves, causes congestion; but the gastric circulation may also be impeded by the alterations in the liver itself. We all know that, in cirrhosis, venous congestion is induced in the stomach, and may lead to hæmorrhage from the gastric vessels; but, perhaps, we do not so often consider that vaso-motor changes occurring in the normal liver may also lead to gastric congestion. When the liver is removed from the body, and blood is allowed to flow through the portal vein, from a bottle containing it, by means of a cannula and india-rubber tubing, we notice that the liver is almost like a sponge—swelling out enormously when the pressure is increased by raising the bottle, and diminishing greatly when the pressure is lowered. We also notice that the flow through it may vary to an enormous extent. Sometimes the blood seems to stream through the organ, as though it presented no obstruction whatever; while, at other times, it will only pass through in a fine stream, or even drop by drop, notwithstanding the tolerably high pressure behind. These observations show that the vessels of the liver, so long as it retains some vitality, even after its removal from the body, are capable of great dilatation and contraction, and have very considerable contractile power. This power, if exercised during life, cannot but influence very greatly the circulation in the stomach and intestines; and, if the hepatic vessels contract very much, they may lead to congestion of the stomach. In the condition of so-called biliousness, we find that there is, in some cases, the craving appetite which I have already mentioned, sometimes passing into anorexia, or we may have the anorexia without any craving. It is possible, indeed probable, that these symptoms may be partly produced by the entrance of bile into the stomach itself, where it will interfere with the gastric digestion. But we sometimes find, in cases of biliousness, these symptoms, without having any evidence that the bile has actually entered the stomach; and, therefore, it seems probable that the alterations in the appetite may, to a great

extent, be due to alterations in the gastric circulation, caused through vaso-motor changes in the liver. Another factor in the production of flatulent distension is, no doubt, the imperfect movements of the stomach; or, their imperfect co-ordination interfering with the expulsion of gas through the cardiac or pyloric orifices.

From the causation of the weight, pain, and flatulent distension in cases of dyspepsia we may deduce rules for treatment. And first as to diet: we must have regard to the rules already given for complete mastication, not merely because the food is more readily dissolved when it is thoroughly broken up, but because prolonged mastication induces a freer flow of saliva. This alkaline fluid, when it reaches the stomach, acts as a stimulant to the mucous membrane, and induces a more copious secretion of gastric juice, so that the complete mastication of food in the mouth has the double action of aiding and accelerating gastric digestion; but if we are to get this stimulating effect of the saliva, the stomach must not be full of fluid when the saliva reaches it. It is a good rule, therefore, for persons suffering from flatulence to begin their meals with solid food, and not to take any fluid until the meal is pretty far advanced. We find that patients not unfrequently begin their meals with a draught of some fluid, such as tea or coffee, and then proceed to the solids. After a meal taken in this way, they suffer from flatulence, but are free from it if they begin with the solids instead. Soup appears to be less objectionable, and the patient may sometimes be allowed to take soup at the beginning of dinner; but he should never be permitted to commence his breakfast with tea or coffee. Occasionally it will be of advantage, even at dinner-time, to begin with solids. Where the stimulant action of the food is insufficient, even when taken in this way, we must add to such action by the use of weak alkaline solutions, to be taken before meals, as, for example, ten grains of bicarbonate of soda, with a little bitter infusion. The time for administering this will vary, but it will probably be found best about twenty minutes before meals, though sometimes twenty-five minutes or half-an-hour. Sometimes we find that a little alcohol with the meal is beneficial, stimulating the stomach, and increasing the circulation, but in other cases we find that it is decidedly injurious; and that, although its local action on the stomach may be unobjectionable, and its immediate effect agreeable enough, yet after its absorption it seems to derange the liver, causing dulness and

heaviness to come on a few hours after the meal. One cause, and not an unfrequent one, of indigestion from atony of the stomach, is simply that the stomach, like the rest of the organism, is tired. A man will sometimes work the whole day, until he is nearly exhausted, and then, hurrying home, will at once eat a heavy meal. His whole nervous system is exhausted, and his stomach shares in the general fatigue. It is unable to meet the sudden call thus made upon it; digestion goes on slowly, and thus the individual suffers from weight, distension, and flatulence. Most of these cases occur in men who work their brains more than their muscles; and it is generally utterly useless for the medical man to tell the patient not to work so hard. He *will* work, and then he calls upon the doctor to shield him from the consequences of his indiscretion. The best thing to do, in these cases, is to insist that the patient shall lie down and rest for ten or fifteen minutes before dinner. If he be above middle age, a little wine just at the commencement of dinner may considerably aid his digestion. There is a physiological reason for the glass of sherry so often taken with the soup at dinner; it stimulates the stomach before the food has been ingested, and thus its subsequent digestion. But it is chiefly in men above middle age that this is required, as was, I think, well shown in the experiences of the Ashantee campaign, as recorded by Parkes. It was found that, when the ration of rum was served out to the troops on halting at night, the younger men did not seem to care for it, but the elder ones wanted their own and that of their comrades too. This might, doubtless, be partly due to the different character of the old and young soldiers, but I think probably not entirely so. It probably indicated, to some extent at least, the physiological want of a gastric stimulant, felt by the elder men, for whom the short rest after the march, during the time the evening meal was being prepared, was not sufficient to remove the fatigue which would have impaired their digestion, though the rest without the stimulant was quite sufficient for the younger soldiers. Exposure to cold, as a cause of gastro-intestinal catarrh, and consequent indigestion is sometimes, I think, too little considered. The intestines are but very thinly covered by nature, and the slight abdominal walls are insufficient to protect them from great changes in atmospheric temperature. We can readily see this in the attitude which persons assume when they go to sleep with an insufficient quantity of blankets. They curl

themselves up so that the thighs lie against the abdomen, forming a sufficient covering to the intestines. The intestinal vessels are able to contain a great quantity of the blood in the body, and, as they contract when exposed to cold, so much blood goes to the brain, that the person cannot get to sleep. When we get warm, however, they dilate, allow the blood to leave the brain, and we fall asleep. The thighs thus form an efficient covering in bed, keeping the intestines warm, and allowing their vessels to distend, and the person to fall asleep; but during the day the intestines are not unfrequently exposed to chills. In hot countries, this is well recognized, and all through the East we find that the people wear a shawl or bandage around the abdomen. Some time ago, when visiting Pompeii, I was struck by observing the same thing in the bodies of those who had perished during the eruption of Vesuvius, which overwhelmed the city. The necessity for protecting the abdomen is, perhaps, more readily noticed by the natives of hot climates, who wear little other clothing, than by us, who are better clad all over; but, even here, the necessity for it exists; and in thin persons, who are liable to indigestion, the abdomen should be well covered by a flannel bandage, although there may be no necessity for this in those whose intestines are already protected with a thick layer of omental fat. The best form of bandage is a double strip of flannel, about seven and a half to eight inches broad, and long enough to go once and a half round the body. The overlapping part should be in front, and should be simply fastened with a couple of safety-pins. These I find to be more easily adjusted, and less troublesome than straps, tapes, or buttons.

Another cause of indigestion is disordered relation between the stomach and the liver. Usually, the bile does not enter the stomach, but remains in the duodenum and intestines, but, when indigestible and irritating substances enter the stomach, the bile may flow into it, producing very unpleasant symptoms; not merely does it interfere with digestion, by precipitating pepsine, but the local irritation which it produces in the stomach itself, as well as its general effect upon the nerve centres after being absorbed into the blood, causes the patient to suffer from dulness and headache. In Dr. Beaumont's interesting experiments upon Alexis St. Martin, he notes, that where he introduced several muslin bags, containing various articles of diet, into the stomach, St. Martin, shortly after their introduction, began to complain of "a sense of weight and

distress at the scrobiculus cordis, slight vertigo, and dimness of vision. These continued to increase, and became quite severe, accompanied, at the latter part of the time, by slight pain in the forehead and through the eyes, and a sense of tightness or stiffness across the breast. His countenance had changed from a florid and healthy, to a sallow, sickly appearance during the experiment, and a soreness at the pit of the stomach continued, after the extraction of the bags, for eight or ten hours; and had not entirely subsided next morning. Morbid action of the inner membranes was evident next day, with considerable erythema and aphthous appearance." Some of the bags were covered with a thick, mucous coat, tinged with yellow bile; and to the entrance of the bile into the stomach, Dr. Beaumont ascribes the symptoms observed in St. Martin, as he had noticed them also in similar experiments.[1] Here, it was apparently the irritation of the indigestible muslin bags which caused this bilious attack in St. Martin; but other indigestible substances will produce the like effect.

Nor is this the only disturbance in the relation between the liver and alimentary canal, which is of importance in the production of indigestion. I have mentioned the probable effect of vaso-motor alterations in the liver upon the vascularity of the stomach and intestines, and upon the solution and digestion of food within them. But there remains still another condition of great importance. The digestion of food is not entirely accomplished in the alimentary canal. In addition to what used to be called the primary digestion in the stomach and intestines, there is the secondary digestion, which appears to be of no less importance. Farinaceous foods are converted, in the intestinal canal, into grape sugar, but apparently only a small amount of this sugar reaches the general circulation unchanged. It first undergoes conversion into glycogen in the liver, and is thence passed out, as it is wanted, into the general circulation. The albuminous constituents of the food are converted, in the alimentary canal, into soluble peptones, but, like the sugar, these also do not reach the general circulation unchanged. Excess of sugar in the systemic circulation is injurious, as we see in cases of diabetes, but excess of peptones appears to be still more injurious. The action of these bodies has been recently investigated by Professor Albertoni of Genoa, and by Professor Ludwig and Dr. Schmidt-Mühlheim in Leipsic. Albertoni has found that peptones,

[1] *Physiology of Digestion*, 2nd Ed., Burlington, 1847, p. 271.

when injected into the circulation, deprive the blood of its power of coagulation, at least in dogs and cats, and probably in all carnivorous animals. It has not the same power in sheep or rabbits, and probably has not the same action in herbivora as in carnivora. Ludwig and Schmidt-Mühlheim also observed the effect of peptones on the coagulability of the blood, and they have investigated their action upon the blood-pressure. They found that when the peptones are injected into the veins the blood-pressure sinks considerably; and, if the quantity introduced be great, a soporose condition, convulsions, and death are produced. It is therefore evident that, unless there were some provision for the alteration of peptones before they enter the general circulation, we should be poisoned by the products of our own digestion. Ludwig and Schmidt-Mühlheim were unable to settle precisely where the peptones underwent transformation, most of them having apparently already disappeared from the portal blood before it reached the liver. Two other observers, Plosz and Görgyai, were led by their experiments to fix upon the liver as the place where peptones undergo transformation, and it seems not improbable that to some extent they are right. The liver, like the stomach, may be overworked, and both organs are liable to great functional disturbance from emotional causes. It is extraordinary how frequently one is able to trace diabetes, or grave functional disorder of the stomach, to grief or worry; and although it is impossible to protect patients from these injurious causes, just as it is impossible to protect them from overwork, yet we must do our best to lessen their injurious effects. Probably the best way of doing this is, to remove from the patient's mind during the hours when digestion is going on, so far as is possible, the source of grief, worry, or anxiety which disturbs him. It is, therefore, well to insist, that he shall give orders that no letters or telegrams be given to him, or any commercial intelligence in the papers be looked at, until at least an hour after dinner.

Another most important factor in the proper regulation of the hepatic function is, the removal of waste products from it. The bile is one of these, and its accumulation in the bile-ducts leads to its re-absorption and circulation in the blood, with all the consequences which the injurious effect of the bile upon the nerve-centres is likely to produce. The bile is secreted under very low pressure, and its expulsion from the liver is effected, to a great extent, by the mechanical pressure exerted upon the

liver by the diaphragm during respiration. When the person leads a perfectly sedentary life, so that no calls are made upon the respiratory organs for increased action, the pressure of the diaphragm on the liver is diminished, and consequently there is a tendency to the accumulation of bile in the biliary radicles, and to its absorption into the blood. This shows the physiological necessity for exercise in persons who are liable to bilious attacks; and of all forms of it, exercise on horseback and rowing are probably the best. Half-an-hour's brisk ride will do more good to the liver than two hours' walking. Here I ought perhaps to have said a few words in regard to cholagogues; but, as I mentioned at the commencement, this subject of digestion is so wide, that to go into it in detail would extend my paper far beyond any limits that could be allowed to it.

THE CAVENDISH LECTURE ON ELIMINATION AND ITS USES IN PREVENTING AND CURING DISEASE.

Deliver d before the West London Medico-Chirurgical Society.

(Reprinted from the *British Medical Journal,* June 20, 1891.)

It seems to me that one of the most marvellous definitions ever given is that of dirt as "matter in the wrong place." The matter need not be in itself objectionable. It may be, on the contrary, exceedingly valuable and useful, provided it be in its proper place and fulfilling its proper function, and yet it becomes dirt at once when put in the wrong place. The pipeclay which is used to keep the soldier's belt clean becomes dirt when it gets upon his uniform, and the blacking which lends lustre to our boots and is used to keep them clean, as it is termed, at once assumes the character of dirt, and exceedingly objectionable dirt, if we put up those boots on a chintz-covered sofa, leaving a black smudge on the fair surface of the fabric.

The utility of things which most people would agree to call dirt is shown by the care employed in sifting cinders, and in separating rags and bones from the contents of our dustbins. But the dust contained in these bins is a most unmitigated nuisance to the unfortunate householder who cannot get it removed. I do not know any topic more calculated to excite a lively conversation amongst householders in London, at any rate, than that of dustbins and drains. The mere mention of either of these words has an effect quite different from that of the "apple of discord," for its effect is a most wondrous concord, every one having the same tale to tell of the neglect of the dustmen and the iniquities of plumbers.

The dustbins are the receptacles for the solid refuse of our houses—the dust, the ashes, the cinders, the odds and ends of dry material—which accumulating in our rooms would render them dirty and disagreeable; but the drain-pipes are the channel by

which the soluble and liquid refuse of our houses is carried away, and any interference with them is still more serious than the non-removal of our dust.

It is only in highly complex communities that the difficulty of removing refuse, either solid or liquid, is felt to an extreme degree. A single individual travelling all by himself in the country has no difficulty whatever. In villages the difficulties are but slight, and even in large camps they may be overcome in a very simple manner, as is shown by that hygienic law of Moses: "Thou shalt have a paddle upon thy weapon; and it shall be, when thou wilt ease thyself abroad, thou shalt dig therewith, and shalt turn back and cover that which cometh from thee."[1] But in cities like London, Paris, Berlin, or Vienna, the difficulty of eliminating the refuse is very great, and enormous expenditure is required to effect it. Each unit in the population contributes to the total amount, and as the population grows, the difficulty increases.

But in large towns the whole refuse of a house does not at once find its way into the dust-bin or the sink. The worn-out furniture, the cast-off clothes and disused utensils which are lumber and rubbish in the houses of the rich, find their way as useful articles into those of the poor, and after a further period of service, descend still lower in the scale of society, passing perhaps through many grades before they are thrown away as absolutely worthless. Even after their fragments have found their way into the dust-heap they are again picked up by scavengers, conveyed to mills or factories, and, after being there transformed into a different shape, are again employed for other purposes.

Now there is a wondrous unity in life and living beings, and the same process which we find going on in towns and villages occurs also in the living beings which compose their population. Nay more, it exists in the tissues and cells of which these living bodies are composed, and even in the unicellular organisms which constitute the simplest forms of life on the surface of this globe. These unicellular organisms are now attracting much attention, for they are the earth's scavengers who tear up the old clothes, crush up the old bones, and burn off the ashes of the world which would otherwise accumulate and render life impossible. But these lowly organisms are not content with breaking up dead matter; they magnify their office and, by attacking living beings, they produce diseases which may lead to the death, dissolution, and ultimately to the complete

[1] Deuteronomy xxiii. 13.

disappearance of the man or beast they attack. Such unicellular organisms, as a rule, have no difficulty in getting rid of the products of waste which are formed by them as well as by the higher animals. As a rule they live and grow in some fluid, and their own movement through the fluid brings them into contact with fresh layers of it from which they obtain new nutriment, and which also washes away their refuse. Should this refuse accumulate to too great an extent, as it does when the fluid is too crowded by the presence of an enormous number of microbes, the refuse products will kill these microbes, just as the unfortunate persons confined in the Black Hole of Calcutta were suffocated by the products of their own respiration.

But just as the broken victuals and old clothes of the rich, regarded by them as simple rubbish, can be utilised by their poorer neighbours, so the fluid in which one class of microbes can no longer grow forms a most suitable soil for others. Thus the liquid in which yeast can no longer grow forms a most suitable soil for the acetic bacillus, and when this in turn has ceased to grow, its place is taken by putrefactive bacilli, and these in their turn are succeeded by moulds.

When unicellular organisms become agglomerated together as in sponges, the difficulty which each organism has in getting rid of its waste material and in obtaining new nutriment is increased, and those cells which are unfavourably placed would probably die very quickly, either from lack of nutriment or from suffocation by their own waste, were it not that this untoward issue is provided against by a peculiar arrangement. Some of the cells become furnished with cilia, which keep up a constant current of water through the interstices of the sponge, and thus bring the fixed cells into a similarly favourable condition as their free swimming congeners, with this difference: that, in the case of the free swimming cell, it moves through the fluid in which it lives, while in the case of the fixed cell the fluid flows over it.

This latter arrangement is the one which exists in most of the cells of the higher organisms such as man. Although some cells, like the leucocytes of the blood, swim freely through the fluid which nourishes them, all the fixed cells of which the tissues are formed are nourished by the lymph which flows around them or between them. A constant current is kept up in this lymph by the mere pressure due to exudation from the capillaries on the one hand, and to absorption by the veins and lymphatics on

the other, aided by pressure on the tissues caused by movements. Only in one place, the central canal of the spinal cord, where the delicacy of the tissues requires a constant flow of nutrient fluid, and yet demands an absence of pressure which might injure the nervous structures, is the current of lymph kept up by ciliary motion, as it is in sponges.

As Claude Bernard well puts it, the cells of which our bodies are composed do not live in air. They live in a liquid internal medium, which at the same time supplies nutriment and oxygen and removes waste products. So long as this nutritive medium continues to fulfil its functions, the cells of which our bodies are composed live and grow with perfect indifference to our external surroundings; and so long as a man holds his breath, so that the fluid medium is unaltered, it is a matter of indifference whether he has his head in a bag of oxygen or in a brewer's vat filled with carbonic acid.

But the fluid medium or lymph very quickly becomes altered by the living cells, which drain it of its oxygen and pour into it their waste products, and in the course of a few minutes it would become quite unable to support their life, were it not gaining supplies from without of oxygen and nutriment, and eliminating or destroying the waste products poured into it. I say destroying, because when the lymph passes into the blood the waste products appear, to a certain extent at least, to undergo oxidation, just as the sewage of villages high up the Thames becomes oxidised or destroyed before it reaches the mouth of the river or the open sea. But various conditions may tend to interfere more or less with the discharge of the sewage from the cells, as well as with their supply of nutriment and oxygen, and it is with this discharge of sewage or elimination of waste products from the cells which compose our tissues into the blood and its excretion from the body as a whole that we have particularly to do to-day.

It is not merely the elimination of the natural waste products of our tissues that we have to consider, but the elimination of waste products formed within our bodies by disease germs which have entered them. These disease germs, consisting as they do chiefly of bacilli or micrococci, resemble the cells of our bodies in the fact that they also may be destroyed by their own waste products, but when they enter our bodies the substances they produce—harmful though they might be, if in excess, to the bacilli themselves—are usually still more harmful to the cells of the tissues, and so weaken

them as to give the microbes a better chance of success in the struggle between them and the organism into which they have entered. Though opinions may differ as to the exact mode in which the organism destroys intruding microbes, or intruding microbes destroy the organism, there is no doubt about the fact that a struggle does exist between them, and the recent experiments which have been made on such a large scale with Koch's tuberculin have shown that this fluid, although sometimes useful and productive of benefit to patients, not infrequently has an opposite action, and appears to assist the development and growth of the tubercle bacilli already present in the lungs or elsewhere. The apparently contradictory results obtained by the use of tuberculin seem to be explained by the observations of Brieger and Fraenkel in regard to diphtheria. These observers have discovered that the diphtheritic bacilli produce two substances, one of which is toxic to an animal, and the other of which is protective. These substances differ in their power of resisting heat, the toxic substance being destroyed at a temperature of 55° C. to 60° C., while the protective resists a temperature not much below the boiling point. These substances appear closely allied, and it is just possible that one may be transformable into the other. What their relationship to one another is we do not at present know, but if we look at the vegetable kingdom we find that in numerous instances poisons closely allied chemically to one another are present in the same plant, but have an antagonistic action to one another. Thus in calabar bean we have physostigmine and calabarin, of which the latter stimulates and the former depresses the spinal cord; and aborandi contains two alkaloids, pilocarpine and jaborine, having entirely different actions, and, indeed, jaborine antagonises the action of pilocarpine. Many alkaloids contained in the same plant seem to have a simple relation to one another; either the one contains the elements of water more or less than the other, or an atom of hydrogen in the one is replaced by a molecule of methyl in the other. Whether some such simple relationship as this exists also in the products of bacteria we do not yet know, but there is little doubt that further researches will soon throw much light on the chemical nature of bacterial poisons. One noticeable point in regard to the resistance of animals to such poisons is that an abundance of glycogen in the liver increases its power to destroy the action of such poisons as pass through it. This power diminishes as the glycogen disappears, and what is true for the liver is probably

true for other parts of the body. At any rate, we know that when animals are starved the glycogen disappears both from the liver and the tissues, and starvation greatly increases the liability of an animal to succumb to infection. But, putting aside the question of neutralisation of bacterial poisons by the lymph or tissues, it is evident that if the toxic products of any bacillus can be washed out of the organism, that organism will have a better chance, and experience confirms the theoretical view that free elimination, both by the kidneys and the bowels, is useful treatment in infective diseases.

Turning again to the normal products of tissue change, we note that probably the most important parts of a cell are its nitrogenous components or proteids. The chief products of nitrogenous waste are urea and uric acid, and the relative quantity of each varies in different classes of animals. The urea forms the chief product of waste in the amphibia, but in the reptilia and in birds the waste appears almost entirely in the form of uric acid combined with bases. In man we have a mixed condition, as the waste occurs partly in the form of urea and partly in the form of uric acid, the proportion of acid to that of urea being about 1 to 33. It is usually supposed that there is a greater tendency in some persons to the formation of uric acid than in others, and that this tendency is associated with a gouty or rheumatic diathesis. In a number of exceedingly interesting and valuable papers Dr. Haig has shown that the excretion of uric acid is greatly influenced by the comparative alkalinity or acidity of the blood, and that the amount of acidity [1] may be made to vary within very considerable limits by the kind of food, by the process of digestion, and by the use of various drugs.

There are certain parts of the body more especially in which the uric acid, wherever it may be generated, has a tendency to get stored up, and this is especially the case in the spleen and the joints, which may be compared to dustbins. Whenever the blood becomes more strongly alkaline than usual it tends, like an active housemaid, to sweep up the uric acid dust out of these bins, with the result of causing great discomfort to the organism generally, for the uric acid, thus sent on its travels, attacks the nerve centres and the vessels, producing headache and depression of spirits, so that gouty people will frequently object to the use of alkalies

[1] The blood is never acid, but diminished alkalinity may, for the sake of convenience, be spoken of as comparative acidity.

because, as they say, they are very lowering. Acids, on the contrary, prevent the blood from taking up the uric acid, and lead to its being concentrated in the dustbins already referred to, so that acids relieve the depression, remove the headache, but, at the same time, tend to cause pain in the joints and accumulation of uric acid in the spleen. Here it lies without producing any inconvenience for the time, but it may possibly be stored up to such an extent as to cause great discomfort or even danger when this large dustbin comes to be cleared out.

A year or two ago I had a very striking case illustrative of Dr. Haig's views. A gentleman, who had suffered from chronic malaria, had an enormously enlarged spleen. That organ began to contract, and simultaneously the patient began to suffer from repeated attacks of renal colic, due to small uric acid calculi, at intervals of two or three weeks. So frequent were these attacks that I thought he must have had an accumulation of small stones in his kidney, for I did not fancy he could form the concretions sufficiently rapidly to cause such frequent recurrence of the renal colic. *Post-mortem* examination, however, showed that I was mistaken, for there was no calculus whatever in either kidney.

Retention of uric acid in the spleen, according to Dr. Haig, is accompanied by its absence from the blood, and consequently by a feeling of well-being and jollity, which may, however, pass into an entirely opposite condition when the uric acid, which has been stored up during this period of retention, again finds its way into the circulation. Thus while a glass or two of champagne, by increasing acidity, drives the uric acid out of the blood, and consequently gives rise to hilarity and happiness in the person who has taken it, it will give a gouty man twinges in his joints, by causing the uric acid to lodge in them, and may cause much subsequent headache and depression when its first stimulant effect has passed off and the imprisoned uric acid again enters the circulation.

Even more serious consequences than depression and discomfort may, according to Dr. Haig, be produced by the rapid removal of uric acid from its chief dustbin or storage place—namely, the spleen—into the circulating blood; for, instead of only affecting the mental faculties, it may attack the heart with fatal results. As an instance, he gives the death of the late Canon Liddon, who had recovered from an attack of gout in the head, and was feeling fairly well even after the fatigue of a railway journey, but suddenly

fainted shortly after breakfast, and died. Dr. Haig's explanation of this is that, during the period of comparative well-being, the uric acid had been stored up, and when the blood became more alkaline, as it does during digestion, and dissolved a part of it out, the liberated uric acid contracted the arterioles, thus raising the tension so that the heart was unable to overcome it, and causing fatal syncope.

Haig's theory of the storage of uric acid is, I believe, very much the same as that of Sir A. Garrod, namely, that this substance is formed in the kidneys out of waste products derived from the nitrogenous tissues generally or from the liver. Part of it is at once excreted, but part of it may return from the kidneys, and either circulate in the blood or get stored up in the spleen. If we return to our analogy of the dust in the house, it is as if the ashes, crumbs, and waste vegetables were thrown together into an ash-bucket to be emptied, but, if this emptying were imperfectly done, the remnants would be thrown into a dustbin within the house, and could not be cleared out directly to the outside, like the ash bucket, but would require to be emptied by bringing it through the passages of the house, which would lead to much discomfort.

The alkaline constituents in the blood are the natural solvents of uric acid, and anything that increases their proportion in the blood renders the uric acid more soluble, so that it is more readily removed from its place of storage and brought into the general circulation, where it produces manifold discomforts. Thus it is that alkaline remedies in gouty patients are so apt to give rise at once to the complaint of their being lowering, not because they have a depressant action of their own, but because they withdraw the uric acid from its lurking-place, and allow it to act upon the nervous system, thus producing depression.

The alkalinity of the blood is increased when the materials of gastric juice are withdrawn from it during digestion, and at this time not only is the urine frequently neutral or alkaline, but the gouty man may suffer from the discomfort due to the circulating uric acid, and fall asleep over his paper after breakfast, or feel stupid and drowsy after lunch when he ought to be attending to his business.

On the other hand, anything that diminishes the alkalinity of the blood—such as acids or wines, and condiments containing acid, nux vomica, opium, and iron—tends to drive the uric acid out of

the blood into its storehouses, and so produces a feeling of well-being which may, however, be only temporary and illusory, as the uric acid is not eliminated from the body but only stored away within it, and when the blood becomes alkaline after another meal or after a dose of soda, all the uncomfortable feelings produced by uric acid may again torment the patient.

Again returning to our illustration. If the contents of our dustbin were carried through our passages, they would be flying about, and great discomfort would ensue; but if we took care to wet each bucketful with a deodorising solution there would be neither flying dust nor disagreeable smell, and the clearing out would be done with a minimum of trouble. In the gouty man's body salicylic acid seems to have a similar effect to wetting the dust; it accelerates the elimination of uric acid while preventing its disagreeable action, and Dr. Haig advises a prolonged course of this drug as a means of permanent cure in gouty patients.

It is hard to say at present what the natural solvent of uric acid is in the body, for it is quite clear that people generally have not got salicylic acid regularly circulating in their blood. Sir William Roberts considers that the pigmentary substances which one finds in the urine probably have a solvent action, and it has occurred to me that possibly a pyrocatechin, which is almost constantly present in the urine, and is nearly related chemically to salicylic acid, may be one of the natural solvents, but I have not yet been able to test this idea experimentally.

I have entered thus fully into Dr. Haig's view of the pathology of gout and the elimination of uric acid because I regard his work as one of the most important contributions which have been made for many years to our knowledge of gout and rheumatism. I do not myself think we have yet got to the bottom of the question. In all probability we shall find that the proteid waste which yields the raw material for uric acid is quite as important, or more important, than the uric acid itself, but Dr. Haig has, at any rate, supplied us with a useful working hypothesis, which may enable us both to foretell the results of certain indiscretions in diet or regimen in gouty people, and to supply us with the means of alleviation or cure. Besides the salicylate of soda, upon which he lays so much stress, we find that gouty people are accustomed to trust to baths and watering-places of all sorts for relief, and no doubt a visit to Homburg, Aix-les-Bains, Carlsbad, Marienbad,

Brides-les-Bains, Baden-Baden, Wiesbaden, Harrogate, Bath, or Strathpeffer will all greatly improve the health and often protect patients from gouty symptoms for many months, or even years, afterwards.

In visiting all these watering-places one is struck by the diversity of the constituents of all those world-famed springs and the constancy of one ingredient, namely, water. In watching the patients one sees that people who at home never touch a drop of water pure and simple from year's end to year's end, taking it only in the form of wine, beer, tea or coffee, will, at a spring, drink tumbler after tumbler of water containing common salt with minute traces of other things—as at Wiesbaden or Baden-Baden —or the same constituent with rather more lime-salts at Homburg, sulphate of soda and carbonate of soda at Carlsbad or Marienbad, or sulphuretted hydrogen—as in Aix-les-Bains, Harrogate, or Strathpeffer. I do not mean to say that the saline or gaseous ingredients of these springs are without effect upon the organism —far from it—but at the same time I feel quite convinced that very many people would never require to go to watering-places if they would drink more water at home.

Water is the most universal solvent in the world. It is not only useful to wash out our closets and flush our drains, it has a similar effect in our bodies, and tends to wash away the waste products from the cells of which our organs are composed, to clear out the uric acid, urea and phosphates through our kidneys and thus prevent renal or vesical calculi, and also to wash out our liver and prevent gall-stones, while it helps to keep the bowels in action. The liver especially is an organ which suffers much from want of water, and I never see a case of gall-stones without asking the patient, "How much water do you drink?" Almost invariably the answer is, "I hardly ever touch water. I am not a thirsty person," and on one occasion a lady called for a particular teacup, which held little more than a thimbleful, in order to show me how much she drank. On reckoning how much water she took in the 24 hours it came, as nearly as I could calculate, to 16 fluid ounces. What wonder then that she had a gall-stone! The poor liver had not a chance to make decently fluid bile, and naturally there was a deposit. By making such people drink a big tumbler of water, and especially hot water, every morning with or without some Carlsbad salts added to it, and, if necessary, repeating the hot water once or twice more in the day, the renewed formation of

gall-stones may frequently be averted, and symptoms of biliary colic, to say nothing of so-called biliousness, may be prevented for many years or perhaps entirely. But some patients will not do this at home, and if you were to tell a fashionable lady to get up at six o'clock in the morning and walk round Grosvenor Square with a tumbler of hot water in her hand, taking a sip at it every three steps, to go on doing this for an hour together, then to buy at a confectioner's a penny roll and eat this without butter for her breakfast, with a small cup of coffee and nothing more, she would probably laugh in your face or apply to some one else for advice. But all this and more you secure by simply advising her to go to Carlsbad. There she finds everybody else doing the same thing, and instead of marching round and round all by herself or accompanied only by little boys who might point the finger of scorn at her, she finds herself in the company of all the fashionable visitors to the bath, and marches to the music of a brass band. The company of others enables her to carry through the tiresome process and to comply with the troublesome restrictions, while the benefit she is sure to derive from it probably makes her feel so strong and happy that she swears by the place ever after, and returns to it again and again. For people who can afford it a visit to such places supplies the best means of cure, but for those who cannot an excellent substitute may be found in the daily consumption of hot water, if they will only have patience and perseverance in its use.

The process of washing out is not only useful in biliary calculus, it is of the utmost value in preventing renal gravel and calculi. The process may be carried on at home by means of hot water either alone or with the addition of a small quantity of some saline, such as bicarbonate or nitrate of potash. In cases where the patient dislikes hot water alone, a slice of lemon thrown on the top of it gives it a slightly agreeable taste, and may overcome the patient's repugnance.

The two watering-places where patients with renal calculi chiefly go are Wildungen and Contrexéville, with its neighbours Vittel and Martigny-les-Bains. What strikes one in the waters of these places is that, in addition to other salts, they contain a very minute trace of iron, which appears certainly to be beneficial to the patients. It is supposed to act by astringing the mucous membrane of the pelvis of the kidney, and so allowing the calculi to slip down more easily.

There are several other methods of cure which I believe owe their virtues to the fact that they produce pretty complete elimination of waste products by causing the patient unconsciously to imbibe a large quantity of water. These methods are the grape cure, the whey cure, and the milk cure. For the grape cure the patient resorts to some warm, sunny place, where the grapes grow well, and there eats many pounds in the course of the day, while other articles of diet are correspondingly diminished. The ripe grapes contain an enormous proportion of water and very little solid matter, so that the grape cure really comes to be a combination of water-drinking and semi-starvation, greatly resembling the Carlsbad cure, to which an additional likeness is given by the laxative effects of the alkaline tartrates contained in the grape juice. The whey cure is very much the same, with the exception that, instead of eating grapes, people drink whey, and that the climate where the cure is carried out is usually a high and bracing sub-alpine one, instead of being soft and sunny. The milk cure is one frequently used in this country with great advantage, more especially in cases of typhoid fever, in chronic diarrhœa occurring in persons who have come from tropical climates, in glycosuria, albuminuria, and some cases of heart disease. Its advantage in typhoid fever is so universally acknowledged that one need hardly say anything about it, but I think it is possible that its efficacy may not be due merely, as is usually supposed, to the milk supplying a bland and non-irritating diet, but may possibly be due also to the waste products of the organism being washed out by the large amount of water which is either contained in the milk itself or added in the form of lime-water or soda-water to it. The results of an exclusively milk diet in chronic diarrhœa are sometimes quite astonishing, and a few months ago I had a letter from a patient who had been suffering from it for ten years, had tried all sorts of medicine in vain, had just come back from Carlsbad worse than he went, and had nearly given up hope of cure. I saw him only once, and told him that the medicine I gave him might do him good or might not, but that if he did not get well his only hope was to put himself on milk and milk only. This treatment, as he informed me by letter months afterwards, cured him as if by a charm.

In diabetes the milk cure requires to be used with care, and the cases for its use must be selected, for some patients may be injured by the insufficient nutriment which it affords, while others are

greatly benefited by it. The cases in which it answers best are, I think, not those of pure diabetes, but rather those of gouty glycosuria, more especially those in which glycosuria is attended by albuminuria, and where the low specific gravity of the urine, after fermentation, leads to a suspicion of contracted kidneys. In such cases, and also those of gouty kidney where the urine is free from sugar and has a low specific gravity with a trace of albumen, a diet in which milk forms the chief or only ingredient tends to ward off spasmodic dyspnœa or the uræmic condition which so frequently occurs from imperfect elimination in old gouty cases.

But we must turn now to another channel of elimination, namely, the bowels; and this channel is little, if at all, less important than the kidneys; and, indeed, in the popular mind, it is more important. There is a great deal of truth in the two rules of long life: "Keep your mind easy and your bowels open," and, indeed, easiness of mind depends very much upon the state of the bowels. I remember reading many years ago a story relating to this subject by Dr. John Brown in *Horæ Subsecivæ*. It was to the effect that a certain Lady Margaret sent a message down late one night to an old clergyman who lived in the manse not far from her castle, to say that she was in great distress about her soul. "And how are Lady Margaret's bowels?" asked the old gentleman. He learned that the bowels were remiss in their duty. "Here are two pills," said the old man to the messenger. "Let Lady Margaret take them to-night, and I will come and talk to her about her soul to-morrow morning." On going up next day the old man found that there was little for him to do, for the pills had done their work, and, as far as Lady Margaret's feelings went, had restored health to her soul as well as to her body.

There is hardly a room in the house but will become dirtier if you cannot get your dustbin emptied, and there is hardly an organ in the body that does not suffer if the bowels become constipated. Not only the brain, but the heart, liver, lungs, stomach, and kidneys have their functions impaired when the bowels cease to do their duty. Napoleon's disaster at the battle of Leipzig is popularly set down to his having eaten a bun in a hurry and so brought on dyspepsia; but it would be a very curious page of history if we could learn how many wars, how much bloodshed, and how much cruelty have had their origin in imperfect action of the bowels. Washington Irving, in his *Lives of the Caliphs*, tells of a certain

emir named Al Hejagi, who suffered for many years from dyspepsia, and this wretched man distinguished himself, perhaps above all other rulers who have ever lived, in the enormous number of people whom he sentenced to imprisonment and death. He is said to have caused the death of no fewer than 120,000 persons, besides those who fell in battle, and to have left 50,000 in prison when he died himself. How much of all this misery might possibly have been averted by the judicious use of mild aperients it is as impossible for any one now to tell, as it is to estimate the debt of gratitude which Europe owes to the physician of Louis XIV. for the care he took of the bowels of that august monarch.

In mitral disease and in dropsy, either cardiac or renal, the benefit derived from the free use of compound jalap powder is very great, and in his work on *Purgative Medicines* Dr. Hamilton describes most forcibly the advantages he obtained from purgatives —employed in such a way as merely to clear out the bowels but not to produce violent purging—in typhus, scarlet fever, marasmus, chlorosis, hæmatemesis, hysteria, chorea, and tetanus.

Like all good plans, that of purgation has been carried to great excesses, and its use has frequently degenerated into its abuse, so that it has fallen too much into neglect, and been replaced by the feeding-up system. This, too, is good in its way; but we must always remember that if we want a fire to burn brightly we must not only pile on the coals but also ply the poker to remove the ash. Neither the coals nor the poker alone will do—we must combine them; and neither the feeding-up system nor the purging system alone will do, but we must combine them in such measure as is necessary for the welfare of our patients. Now, Nature has herself provided a certain regulating mechanism to attain this end; for, as my friend Dr. Cash has shown, each time that food enters the stomach the bowels receive a certain impetus which is sufficient in healthy people to carry the refuse out and produce an evacuation once a day, the final impetus being usually given by the breakfast, which is sometimes followed by a cigar. In some people, however, the stimulus given by the food is not sufficient, and in these people it may be necessary to give a laxative daily. It is no doubt better to do without this, if possible, and by strict attention to regularity and soliciting Nature at the same hour every day, whether there be any desire to defæcate or not, the bowels may at length become quite regular.

Exercise in many cases is an adjunct, and the mechanical com-

pression which the intestines undergo from the action of the abdominal walls stimulates them to increased contraction. More especially is this the case if the exercise be of the nature of climbing or riding, for in both of these the abdominal muscles contract with considerable power, while in an ordinary constitutional walk along the level road the bowels receive hardly any compression whatever. Where exercise cannot be obtained, abdominal massage, either by rubbing with the hand or by rolling a cannon ball, covered with chamois leather, over the abdomen, may be useful. A draught of cold or hot water in the morning, or before going to bed at night, by supplying moisture to the contents of the intestines, may have the desired effect. The hard, indigestible residue of food supplies a healthy mechanical stimulus to the bowels, and I think that in our efforts to save the stomach we sometimes disregard this need of the bowels, and give food which is too soft, too mucilaginous, and too unirritating. Stewed prunes, or stewed pears, by the indigestible cellulose which is present in them in the form of skins and gritty grains, figs either raw or stewed, raspberry or strawberry jam by the indigestible seeds which they contain, and marmalade by its orange peel, as well as brown or bran bread by its indigestible husks, all supply a mechanical stimulus to the bowels. But even these sometimes fail, or we find that the stomach objects to them, although the bowels may need them, and we must have recourse to the so-called aperients. Frequently when I prescribe a dinner pill, patients say to me: "But, doctor, it is not natural that I should take medicine every day." I say to that: "Quite true. Nor is it natural that you should keep a cook; and if your cook removes from your food everything that is stimulating to the intestines, you must take something to replace what your cook has taken away. If you will go back to the manners and customs of the ancient Britons, live in the green wood and eat acorns and pignuts, you will not want any dinner pills."

Now the dinner pill supplies a very useful stimulus, and I know a man who has taken one every day of his life for forty years, apparently with great benefit to himself. But there are some people who do not seem to thrive on dinner pills, and they either do not get any action at all, or they get too much. In such cases, instead of giving the intestines one great push once a day by the dinner pill, one may give them a series of gentle jogs by adding to each meal a minute quantity of a purgative; and I find one-tenth of a grain of aloin, given with each meal, sometimes succeeds when

other measures fail, and even these small doses appear sometimes to be too much.

Now, our bodies are like houses in more than one respect, and it is usually found that although each house may be dusted out once a day, there is a regular cleaning up with extra sweeping once a week; and, in addition to this, there is the spring and autumn cleaning of the whole house. Dinner pills and stimulating diet are like the ordinary daily dusting, and while they may answer for some persons, others find that, in addition, they require a weekly clear out, and if this be not given to them by means of a cholagogue purgative, they have a regular sweep out about once a month by getting a violent migraine with bilious vomiting, and generally they are obliged to fast for at least one day during the continuance of the headache. Besides this, our forefathers used to have a regular clearing out in the spring and autumn not from the bowels but from the blood-vessels directly, and they were accustomed, as they said, "to be let blood" in the spring and autumn.

The effect of a cholagogue purgative such as a mild mercurial, as, for example, a small dose of calomel, of blue pill or of grey powder, followed by some saline, is sometimes very remarkable. I have seen a quarter of a grain of calomel, with a seidlitz powder next morning, change as naughty a little girl as you wouldn't wish to see into a perfect little angel, and I well remember a little experience which I had some years ago at a friend's house. One morning at breakfast a little boy was very troublesome, and, instead of taking his oatmeal porridge as he ought to have done, he was nudging and bothering his little sister, who was sitting beside him. I said to my friend, "I think your boy's digestion is out of order." "Oh, no," he said, "it is only naughtiness"; but the naughtiness increased so much that the little boy had to be forcibly removed from the table. As soon as the expulsion was effected my friend said, "You are quite right; his breath does not smell right." In such cases as this I do not know any medicine that is better than some Gregory's powder, because it has both a moral effect and a physical action. Its nasty taste when administered as a punishment is wholesome morally, while its action upon the liver and digestion is most useful physically.

Not infrequently adults suffer from nervous irritability, depression, weakness, and inability to do anything, and this is put down on the part of their friends, and frequently of their doctors, to neurasthenia and hypochondriasis. They are treated with nervine tonics,

nervine sedatives, change of scene, change of air, baths, waters, advice or scolding, and all to no good. Nervous and depressed they still remain. In some of these cases one may notice a large amount of mucus in the motions, and sometimes there appear to be actual casts of the intestines, long membranous-looking shreds apparently tubular in their nature. This condition has been described by the late Sir James Simpson under the name of membranous enteritis, and it is not only usually said to be associated with hypochondriasis, but often it is looked upon as the consequence rather than the cause of the nervous condition, which is certainly its usual concomitant. But it is of no use here to treat the nerves. If you wish for any good results you must treat the bowels. In some, probably in many, cases it depends upon the partial constriction of the intestine near the junction of the sigmoid flexure with the rectum. The motions, lodging here, tend to cause an inflammatory condition of the mucous membrane and profuse secretion of mucus, which either simply coats the fæcal masses or forms a kind of false membrane. This condition may be due to actual constriction of the lumen of the gut or to a diminution in its calibre from pressure. In children prolapse of the rectum is a very common thing. In adults it is comparatively rare, but in them a tendency remains, not to prolapse of the rectum externally, but of the sigmoid flexure into the rectum, and this condition may give rise to great nervous disturbance, lasting for years and perhaps indefinitely, unless its existence be suspected and the proper treatment adopted.

One useful remedy—strongly recommended by Mr. Cripps—is the injection of 2 to 4 ounces of cold water immediately after a motion. This is to be retained, and has, as he expressed it, the tonic effect of a cold bath upon the intestine, increasing the contractile power and lessening the tendency to prolapse. I once saw a case of this sort at intervals for two or three years without ever suspecting its nature. It occurred in a man from New Zealand who had been accustomed to a great deal of horse exercise, frequently riding 40 miles a day. He began to suffer from neurasthenia, hypochondriasis, loss of appetite, failing strength, and emaciation. In fact, he presented almost the typical aspect of the hysterical girls who are so well treated by the Weir-Mitchell plan, and, in consequence of this, I advised him to undergo a course of massage. This he did two or three times with very little good, until, by my advice, he went to Dr. Eccles, who discovered the real cause of his

illness, and, by the judicious application of massage to the intestines, completely restored him to health.

But it is not only in the upper part of the intestine and in the sigmoid flexure that hindrances to elimination exist. Even when the fæcal masses have reached the rectum there may be difficulties in the way of their expulsion. It is usually imagined that nothing can be simpler than to empty the rectum, and yet one of the most grateful letters I ever had in my life from a patient was for giving instructions in this matter. As the poor lady said, she had for many years had great difficulty in emptying the bowels, and no one had ever taken the trouble to instruct her as to the mode of overcoming it. The fact is, one often forgets that the pressure of the abdominal muscles acts in the same direction in defæcation as in parturition, tending to drive the fæcal mass towards the coccyx, and in order that it may be evacuated its course must be finally directed somewhat forward. This change in direction is effected by the muscles of the pelvic floor, but if those are lax, as frequently occurs in persons of sedentary habits, and more especially in women who have had large families, the fæces, instead of being expelled, may accumulate in and distend the rectum. This accumulation is greatly favoured by the construction of water-closets, as in sitting upon them the spine is usually at a right angle with the thighs, the legs are close together, and the pelvic floor is not put upon the stretch. When the body is inclined at an acute angle forward the pelvic floor becomes tighter, and this is still more the case when the crouching or squatting attitude is adopted, which is naturally assumed when emptying the bowels in the open air. In cases where defæcation is difficult this attitude is to be recommended, and a very low commode-pan or chamber-pot should be used in place of the ordinary closet. Should this be insufficient, pressure with the hand close under the tip of the coccyx will tend to force the fæcal mass forward and greatly facilitate its expulsion.

In relation to the complete evacuation of the bowels, I have received a very interesting communication from my friend Dr. Batten: "Mr. R. suffered from pruritus ani, with slight eczema and a small pile. On examining the rectum a small piece of fæces, the size of a flat bean, was found just inside the anal orifice, not only on one occasion, but whenever an examination was made. If the fæces were removed before going to bed (the pruritus occurred more at night) the irritation did not occur. Remembering your plan of treatment with administration of small doses of aloes, I gave them

but without any success. On inquiry, I found that Mr. R.'s bowels were moved with great regularity every morning, and that the motion was not a formed one—at all events, not the last portion of it. Upon this I reasoned that Mr. R.'s failure to entirely empty the bowel was due to the want of solidity of the motion not giving the bowel anything to contract upon. I therefore ordered him occasional doses of lime-water to be taken sufficiently often to cause a formed motion. The result was very satisfactory. The bowel contracted on and expelled the solid motion completely. I think in our desire to keep the bowels regular, we overlook the disadvantages of a fluid instead of a solid motion."

Before concluding this lecture, I will mention a plan which I have found of very great service either in cases of cardiac disease, in fevers, or in conditions of extreme weakness where the feebleness of the heart made it very advisable that the patient should use as little exertion as possible. It frequently happens that patients strongly object to use a bed-pan, and assert, sometimes with a considerable amount of truth, that they are unable to empty the bowels satisfactorily in the recumbent posture. A great deal of the risk connected with the use of a commode arises from the fact that when they use it they generally have to get out of bed and into it again. In these cases I adopt a plan, which I suppose many others have used also, but which I have never seen described. It is to have a strong platform made of rough wood, of such a height that the commode, when placed upon it, is level with the bed. A large, strong packing-box, sawn to the proper height, may answer, or, if this is not at hand, any carpenter can put together a rough but strong construction of the kind needed. If nothing else is at hand, the drawer of a wardrobe turned upside down will do, but it must be supported from below by books or pillows piled up within it, so as to prevent the bottom of it from breaking through, as usually it is not strong enough to support the weight. The commode being pushed close to the bedside, the patient has simply to slew himself round upon it. The body is raised, and the legs are allowed to hang down. After the bowels have been evacuated, he is rolled round on his side into bed. During the whole process no change is ever made in the level of the patient, the only alteration being in the relative position of the trunk and legs with reference to his pelvis. Perhaps some of the new devices for raising the patient bodily from the bed might do better than this, but generally they are not at hand, and the plan which I have

mentioned can always be followed, as some kind of platform sufficiently strong to serve the purpose can be made with boards, boxes, or footstools in every house.

In this lecture I have not attempted to go over anything like the whole field which its title would cover, because I found this to be impossible in the time at my disposal. I have, therefore, attempted to deal only with such points as have more of a practical than a theoretical interest. In concluding it, I thank you most sincerely, Mr. President and gentlemen, for the great honour you have done me in asking me to deliver this lecture, and to beg you to forgive the deficiencies in it, of which no one is more conscious than myself.

THE FERMENT-ACTION OF BACTERIA.

IN CONJUNCTION WITH A. MACFADYEN, M.D., B.Sc.

(Reprinted from the *Proceedings of the Royal Society*, vol. xlvi.)

Received March 23rd—Read April 4th, 1889.

In the course of the research the following micro-organisms were used :—

1. Koch's comma spirillum (Flügge, *Die Mikro-organismen*, Leipzig, 1886, p. 334).
2. Finkler's comma spirillum (Flügge, *Die Mikro-organismen*, Leipzig, 1886, p. 382).
3. A putrefactive micrococcus.
4. Scurf bacillus (Klein).
5. A bacillus isolated from milk by Dr. Klein, which for convenience we may call the " Welford Bacillus."

I.

All of these liquefy gelatine, the two last most energetically. Anthrax was not used, on account of the resistance of its spores and the consequent difficulty of completely sterilising the culture media. The experiments are made in each case with pure cultures.

The first question which we tried to solve was, What is the nature of the substance by which bacteria liquefy gelatine? Is it an enzyme? There are two ways in which they might do this. They might secrete some fluid which would dissolve the gelatine mechanically, without altering it chemically, as saliva dissolves sugar in the mouth; or they might do it by secreting a specific enzyme, which would dissolve the gelatine by altering it chemically, as the ptyalin of the saliva effects the solution of starch. If the solution were effected in the first way by the secretion of a mere solvent, we should expect that when the microbes were removed or destroyed, either by heat or chemical means, the portion of the medium already dissolved would not have any extensive action on

fresh media. But if it had any such solvent action, it would probably continue after the solution had been heated to a temperature sufficient to destroy the action of an enzyme. If, on the other hand, the microbes liquefied the media by secreting an enzyme, we should expect that the liquefied portion would probably dissolve a considerable amount of new medium when added to it, but that its solvent action would be arrested by exposure to a temperature sufficient to inhibit enzyme action.

The culture medium was made by adding to meat broth: gelatine, 10 per cent.; peptone, 1 per cent.; and sodic chloride, 0·5 per cent. The reaction was rendered faintly alkaline with carbonate of soda. In all the experiments Koch's methods to ensure sterile media and pure cultures were followed out.

Tubes of 10 per cent. gelatine were inoculated with the five microbes, and placed in the incubator at 37° C., with the exception of the putrefactive micrococcus, which was kept at 22° C.

When liquefaction was complete the fluid was filtered into sterile tubes, the bacterial deposit being washed with a small quantity of sterile distilled water.

Of the filtrate, one, three, and five drops were added respectively to fresh gelatine, and the tubes placed in the incubators as before. The gelatine liquefied, and in all cases bacteria were present.

This liquefied gelatine was in its turn taken and subjected to a temperature of 50° C. for one hour. Then one, three, and five drops were added to fresh gelatine. After incubating, some of the cholera comma tubes did not liquefy, but in all cases where liquefaction took place it was due to the active bacteria, as proved by their growth on control plates. The control plates were made by adding a few drops of the liquefied gelatine to fresh gelatine, and pouring it out in a sterile glass dish. After incubating at 22° C., the gelatine was examined microscopically, and the presence or absence of bacterial colonies noted.

The liquefied gelatine was next subjected to a temperature of 100° C. for fifteen minutes. The same number of drops were added to gelatine. This fresh gelatine did not liquefy. Finally, 5 c.c. were added to fresh gelatine, but still it did not liquefy.

The control plates showed no colonies.

We therefore conclude that exposure to a temperature of (1) 100° C. destroys—

(*a*) The bacteria.

(*b*) The liquefying power of the fluid.

(II) 50° C. does neither. It was not deemed advisable to continue the sterilisation too long, having regard to the injurious action of heat on soluble ferments.

It was next necessary to determine the temperatures between 50° C. and 100° C., which would be sufficient to kill the bacteria without rendering any ferment which might exist inactive. A series of experiments led to the following results:—

60° C. for half-an-hour killed Koch's and Finkler's spirillum.

75° C. for fifteen minutes, on two successive days, killed the scurf and "Welford" bacilli.

70° C. for fifteen minutes, on two successive days, destroyed the putrefactive micrococcus.

Having established these facts, a series of cultures at 37° C. were made in small glass flasks, each containing about 100 c.c. of 10 per cent. gelatine. The liquefied gelatine was filtered, and the deposit washed with sterile distilled water.

These filtrates from the five series of cultures were sterilised as described above. Then 5—10 c.c. of each were added to 10 per cent. gelatine (20 c.c.) and kept at 37° C., as well as control tubes of sterile gelatine.

On the third day the tubes were removed from the incubator and placed in ice-cold water.

Results:—

Scurf bacillus Welford bacillus	The gelatine does not stiffen, but remains liquid.
Koch's spirillum Finkler's spirillum	The gelatine is semi-liquid, and does not completely re-gelatinise.
Putrefactive micrococcus Control gelatine	The gelatine stiffens.

Control plates. No bacteria.

Kept at the ordinary room temperature, these phenomena persisted, the liquid gelatine remaining liquid, and the solid gelatine not liquefying.

Here, then, we have complete liquefaction of the gelatine produced in the first two cases, partial liquefaction in the next two, and no effect in the last.

That this liquefaction was brought about without the presence of active bacteria is proved by the fact that control plates inoculated from the liquefied gelatine remained sterile. The complete lique-

faction was produced by the sterile fluid from the microbes which were more active liquefiers of gelatine than the others. In the case of the two comma spirilla the enzyme action in gelatine was evidently more feeble. The negative result with the putrefactive micrococcus, and also the fact that tubes inoculated from it, and kept at the optimum temperature of 22° C., also gave negative results, were probably due to the preliminary sterilisation having destroyed both the microbes and any enzyme which they might have formed.

These introductory experiments led to the following conclusions :—

1. 100° C. destroyed both the bacteria and the liquefying power.
2. 50° destroyed neither the bacteria nor the liquefying power.
3. Temperatures between 60° and 75° C. destroyed the bacteria, but not the liquefying power in four cases.
4. The liquefied gelatine treated as under 3, and added to fresh gelatine, liquefied it, although active bacteria were proved to be absent.
5. The liquefaction must, we think, be due to a soluble enzyme, inasmuch as liquefaction still took place after the elimination of the microbes, while it was prevented by exposure to such a temperature as would destroy the activity of an enzyme but would not be likely to affect the action of a simple solvent.

II.

Having regard to the fact that the peptonising action in gelatine was slow, and in two cases partial, it was next sought to determine whether more active liquefaction of the gelatine could be obtained by growing the microbes in some other albumenoid soil.

Two culture fluids were made with meat broth as follows :—

A. Meat broth—	B. Meat broth—
Peptone, 1 per cent.	NaCl 0·5 per cent.
NaCl 0·5 „	

Both were rendered faintly alkaline with the carbonate of soda.

The bacteria grew well in both of these media, and so rapidly and abundantly in B. that further experiments were made with it only, *i.e.* without peptones. For each culture, 100 c.c. meat broth were used. After inoculation and four days' incubation at 37° C., the broth was filtered, and the bacterial deposit washed

with sterile distilled water. It was then sterilised as already described, and 10 c.c. added to tubes of 10 per cent. gelatine. These tubes were placed in the incubator, as well as control tubes of sterile gelatine. When taken out, and placed in ice-cold water, the following results were obtained :—

(1) After 24 hours:

Scurf bacillus, Welford bacillus } Liquid.
Koch's spirillum, Finkler's spirillum } Semi-liquid
Putrefactive micrococcus, Control gelatine } No liquefaction.
Control plates. No colonies.

(2) After 48 hours:

Koch's spirillum, Finkler's spirillum } Liquid.
Putrefactive micrococcus, Control gelatine } No liquefaction.
Control plates. No growth.

From these experiments it will be seen that the enzyme developed in meat broth is more active than that formed in gelatine. In twenty-four hours the gelatine was liquefied by the scurf and Welford bacilli; in forty-eight hours by Koch's and Finkler's comma spirilla. Again the putrefactive micrococcus gave negative results.

Conclusions :—

1. An enzyme is formed in meat broth which liquefies gelatine, and does so more surely and quickly than the enzyme formed in gelatine itself.

2. The liquefaction is produced by a soluble ferment, since its action can be demonstrated apart from the microbes which produce it.

III.

Instead of using heat sterilisation some experiments were made with menthol and thymol.

It was found that when these substances were added in amounts sufficient to prevent the growth of the bacteria—the ferment action was likewise inhibited.

IV.

The presence of a soluble ferment being demonstrated, can we isolate it?

(1) From gelatine.
(2) From meat broth.

(1) *From Gelatine Cultures.*

Flasks containing 250 c.c. of 10 per cent. gelatine were inoculated with the five microbes. They were left in the incubator at 47° C. (putrefactive micrococcus, 32° C.), till liquefaction was complete. The liquefied gelatine was treated with absolute alcohol and filtered. The precipitate was extracted with glycerine, and finally re-precipitated with alcohol. The precipitate, after drying in a sterilised flask, was taken up in a small quantity of sterile distilled water, and allowed to stand over night. About 5 c.c. were then added to 10 per cent. gelatine, and incubated at 37° C.

Results.—Negative. No liquefaction was produced.

(2) *Meat Broth Cultures.*

In each case 250 c.c. were treated in a similar manner—with alcohol and glycerine, and the precipitate and sterile distilled water added to 10 per cent. gelatine.

Results:—

Koch's spirillum Finkler's spirillum Putrefactive micrococcus	No liquefaction.
Scurf bacillus Welford bacillus	In a few tubes the gelatine was viscid. The rest re-solidified.
Control plates.	No colonies.

Concluding that the prolonged method of extraction had weakened the action of the enzyme, a modification of the process was next made in the following manner:—500 c.c. of meat broth were inoculated with the microbes, and left in the incubator for seven days. The precipitate, with an excess of alcohol, was allowed to stand over night, and, after drying, was dissolved in sterile

distilled water, and then re-precipitated by alcohol. This precipitate was dried and taken up in distilled water. The next day about 20 c.c. were added to 100 c.c. of a 5 per cent. gelatine, and placed in the incubator at 37° C.

Results after four days :—

The only positive results were obtained with the scurf bacillus and the Welford bacillus. In these cases the gelatine remained liquid, while the control gelatine re-solidified. The control plates gave no colonies.

Conclusion.—The bacteria do form a soluble enzyme which can be isolated, and its action demonstrated on albumenoid gelatine.

V.

Are the microbes which liquefy gelatine capable of exerting a like action on other proteid bodies?

To test this, experiments were made with—

(*a*) Egg-albumen.
(*b*) Fibrin.

In the first place, it was necessary to find out what resulted from the direct action of the microbes.

Faintly alkaline meat broth, as developing the most active enzyme, was used.

(a) *Egg Albumen.*

To flasks containing 100 c.c. of meat broth were added small pieces of coagulated egg albumen. The flasks were then sterilised and inoculated with Koch's spirillum, Finkler's spirillum, the scurf and Welford bacilli. They were then placed in the incubator at 37° C.

Results :—

(1) Scurf bacillus.
Welford bacillus :—

1st day. No marked change.
2nd day. Albumen broken up into small fine flocculent fragments.
3rd day. Disintegration almost complete.
4th day. Disintegration complete.

(2) Koch's spirillum.
Finkler's spirillum :—
1st day. No marked change.
2nd day. Translucent.
3rd day. Thinned and transparent.
5th day. Disintegration.

The bacteria are therefore able, by means of their peptonising action, to disintegrate egg albumen.

(b) *Fibrin.*

To 100 c.c. of the meat broth small pieces of boiled fibrin were added, and after sterilisation the flasks were inoculated with the same microbes, then placed in the incubator at 37° C.

Results :—

(1) Scurf bacillus.
Welford bacillus.
1st day. No marked change.
2nd day. Fibrin eroded.
3rd day. Breaking up.
4th day. Disintegration complete.
5th day. Fluid has become turbid.

(2) Koch's spirillum.
Finkler's spirillum :—
1st day. No change.
2nd day. Slight erosion.
3rd day. Frayed appearance.
4th day. Commencing to break up.
5th day. Disintegrated
6th day. Turbidity.

Here again we have a marked disintegrating action on fibrin.

Conclusion.—The bacteria exert a disintegrating action on egg albumen and fibrin, as well as on gelatine.

VI.

Can we demonstrate the action of the enzyme on proteid bodies such as egg albumen and fibrin, in the same way that its action was demonstrated on gelatine?

The alcoholic precipitate from 500 c.c. of the meat broth culture was dried at 35° C., and then dissolved in sterile distilled water. It was then re-precipitated by alcohol and filtered. This precipitate was dried in sterile plugged flasks, and to it were added 50 c.c. of sterile distilled water, and 5 c.c. of a $\frac{1}{2}$ per cent. chloroform water. Carbonate of soda was finally added to render the fluid faintly alkaline.

In each flask was placed a small piece of boiled fibrin. After four days in the incubator they were taken out and examined:—

A. From each, gelatine plate cultures were made.
B. The appearance of the fibrin was noted.
C. After filtration the filtrate was tested for digestive products.

A. Some of the plates showed bacteria. The flasks from which these had been made were rejected; only those were used which had remained sterile.

B. In none did the fibrin break up and disappear. But it became thinned and frayed at the edges. This was most marked with the scurf and Welford bacilli.

C. The filtrate was examined for soluble products:—

On neutralising with dilute hydrochloric acid a precipitate appeared. This was filtered off and the filtrate tested for peptones. A solution of caustic soda was added, and then a highly dilute solution of cupric sulphate was filtered down the side of the test tube. At the line of demarcation the rose-coloured peptone reaction was strongly marked.

The simple boiled solution of the ferment only gave the faintest peptone reaction.

These results were obtained with the scurf and Welford bacilli, and Koch's and Finkler's spirillum. To sum up:—

1. The fibrin was visibly affected.
2. Neutralisation produced a precipitate.
3. The peptone reaction was very distinct.

The enzyme therefore, apart from the bacteria, *can* form soluble products from fibrin, and amongst these peptones.

VII.

Are the microbes capable of forming a diastatic, as well as a peptonising ferment?

A. Scurf bacillus.
Welford bacillus :—

Starch was heated with water so as to form a thin paste. To this was added sodic chloride (0·5 per cent.). About 100 c.c. were placed in each flask, which was then plugged with cotton wool and sterilised.

After inoculation they were placed in the incubator (37° C.) along with flasks of sterile starch paste.

Flasks were opened on successive days and examined :—

2nd day. Starch has lost its opalescence. Iodine gives a blue colour.
3rd day. Iodine gives a red colour.
5th day. No reaction with iodine.
6th day. Was tested for a reducing sugar. The reactions were as follows :—

(1) Iodine.—No reaction.
(2) Caustic soda.—On gently boiling fluid becomes yellow.
(3) Cupric sulphate and caustic soda.—A yellow precipitate on boiling.
(4) Fehling's reagent.—A red precipitate.
(5) Barfoed's reagent.—No reaction on gently heating.

(*Barfoed's Solution*:—One part of neutral acetate of copper dissolved in 15 parts of water, and then to 200 c.c., 5 c.c. of acetic acid (38 per cent.) added.)

The control starch gave blue colour with iodine, but none of the above reactions.

B. Putrefactive micrococcus—
Results were negative.
C. Koch's spirillum.
Finkler's spirillum :—

The same starch solution was used, but a few drops of meat broth were added in each case. The usual control experiments were made :—

3rd day. Starch has lost its opalescence. Iodine strikes a blue colour.
4th day. Iodine gives a violet colour.
5th day. Iodine gives red reaction.

7th day. Iodine.—Red.
Caustic soda.—Yellow on boiling.
Cupric sulphate and caustic soda.—No reduction.
Fehling's solution.—No reduction. On previous addition of H_2SO_4 a slight reduction.
Barfoed's reagent.—No reduction.
Control starch.—Iodine strikes blue.

From these experiments the following conclusions may be drawn:—

1. The putrefactive micrococcus did not grow on the carbohydrate soil, and so we are left in doubt as to its diastatic action.

2. The scurf bacillus and Welford bacillus were both capable of cultivation, and evinced a marked diastatic action, in addition to their peptonising power. The failure of the iodine test, and the precipitates obtained with Fehling, etc., indicate the presence of a reducing sugar. The failure with Barfoed's reagent suggests that the sugar is in great part, at any rate, maltose.

3. With regard to Koch's spirillum and Finkler's, though they evinced a diastatic action, it was feebler than in the former case, only traces of a reducing sugar being detected after the addition of sulphuric acid. The red and violet coloration with iodine points to the formation of dextrin (erythro- and achroo-dextrin).

At any rate, in the scurf and Welford bacilli we have two microbes which evince a marked diastatic action; and a demonstration of the fact that the same germ can produce both a diastatic and a peptonising ferment.

VIII.

Can we demonstrate the action of the diastatic enzyme apart from the bacteria?

Starch cultures of the scurf bacillus and the Welford bacillus (two days' growth) were treated with chloroform water (1 per cent.) till they became sterile.

The fluid was then added to fresh starch, and incubated at 37° C.

In eight to ten days the iodine reaction had disappeared. On boiling with caustic soda the fluid became yellow. Fehling's solution was reduced. The fluid lost its opalescence. Control plates—no growth.

These experiments point strongly to the existence of a diastatic enzyme capable of isolation, and of acting apart from the bacteria.

IX.

That the peptonising enzyme bears the closest analogy to the pancreatic ferment will be seen from the following experiments. Sterile meat broth, in which Finkler's spirillum and the Welford bacillus had been cultivated, was added to 10 per cent. gelatine tubes of differing reaction:—

Gelatine.	*Results.*
A. Acidified with dilute hydrochloric acid	No liquefaction.
B. Alkaline by adding sodic carbonate	Liquefied.
C. Neutral	Liquefied.
D. Boiled after adding the ferment	No liquefaction.

X.

The digestive action of the microbes was tested on several other bodies.

1. *Fats.*—Alkaline meat broth and olive oil, 2 per cent.

The results were negative.

Experiments which were made by Manfredi[1] tend to show that fat-containing media impair the vegetative energy of bacteria.

2. *Dextrose.*—The culture fluid was prepared as follows:—

Dextrose	2 per cent.
Peptone	1 ,,
Sodic chloride	0·5 ,,
Reaction	Neutral.

After sterilisation, the flasks were inoculated with the scurf bacillus and Welford bacillus. Incubated at 37° C. They were examined on the fourth day.

Fehling's solution was no longer reduced. The fluid gave a marked acid reaction.

The control solution reduced Fehling's solution. Reaction was unchanged.

[1] *Accademia dei Lincei, Rendiconti*, vol. iii. sem. 1, 1887, p. 535.

3. *Cane-sugar.*—Cane-sugar	. .	2 per cent.
Peptone	. .	1 „
NaCl	. .	0·5 „
Reaction	. .	Neutral.

Inoculated with scurf bacillus and Welford bacillus, and incubated at 37° C.

The results were negative. No reducing sugar detected.

Muscle.—Alkaline meat broth cultures were used. Inoculated with Finkler's spirillum and Welford bacillus.

With the Welford bacillus a marked effect—the muscular tissue becomes disintegrated, and the striæ indistinct.

These experiments, though incomplete in themselves, are sufficient to show that the bacteria which liquefy gelatine and diastase starch, can also exert a digestive influence on dextrose and muscle. The exact determination of the products of this action in the case of these and some other organic bodies must be reserved for further investigation.

To sum up briefly the results of this inquiry:—

1. The bacteria which liquefy gelatine do so by means of a soluble enzyme.
2. This enzyme can be isolated, and its peptonising action demonstrated apart from the microbes which produce it.
3. The most active enzyme is that formed in meat broth.
4. Acidity hinders, alkalinity favours its action.
5. The bacteria which form a peptonising enzyme on proteid soil can also produce a diastatic enzyme on carbohydrate soil.
6. The diastatic enzyme is not so readily separated from the microbes which produce it, but where that has been accomplished its action on starch can still be demonstrated.
7. The diastatic enzyme has no effect on gelatine, and *vice versâ.*
8. The bacteria are capable of evincing an adaptiveness to the soil in which they grow.[1]
9. The microbes are capable of digesting other similar bodies such as dextrose and muscle.
10. Fatty matter was not affected.

[1] For this reason foods may require to be changed several times in diarrhœa, p. 233. Microbes adapt themselves to new diet, but less quickly than the intestine, and so they are starved by changes of diet while the patient is not.

ON A POSSIBLE CAUSE OF CLUMPING IN BACILLI, AND FORMATION OF ROULEAUX BY ERYTHROCYTES.

(Reprinted from the *Journal of Pathology and Bacteriology.* Edinburgh and London, Young J. Pentland, December 1900.)

At the meeting of the Physiological Congress in Cambridge, two years ago, I demonstrated an experiment by which the clumping of bacilli and the formation of rouleaux by the blood corpuscles could be readily illustrated and possibly explained.[1] I did not, however, publish a description of the experiment at the time, and I think it may be advisable to do so now, as it may illustrate and explain the causation of the two phenomena just mentioned. The experiment consists in covering lucifer matches with hard soap, and throwing them into water contained in a large flat trough, such as is used for photographic purposes, or for sterilising surgical instruments. A trough about $1\frac{1}{2}$ in. deep, 8 in. long, and 12 in. broad, answers very well, although, if the experiment has to be demonstrated in a large lecture room, a larger trough should be employed. It should be filled to half its depth, or more, with water, coloured blue with litmus. If the artificial bacteria be now thrown into the liquid they float about indifferently, but if the water be acidulated they at once draw together into clumps, the acidulation of the water being rendered evident by change of colour in the litmus from blue to red. If a solution of caustic potash be now poured into it, the red colour will disappear from the litmus as the reaction of the fluid becomes alkaline, and at the same time the clumps, if stirred with the finger, readily break up and will not re-form. Blood corpuscles may be imitated by cutting slices about $\frac{3}{16}$ in. thick from corks, but this may be done still more readily by cutting discs out of sheet cork of about $\frac{3}{16}$ or $\frac{1}{4}$ in. thick,

[1] While this paper was in the press I demonstrated this experiment to the Physiological Section of the Thirteenth International Medical Congress in Paris.

by means of a cork borer $\frac{3}{4}$ in. in diameter. These should be loaded at one side by cutting a hole about $\frac{1}{6}$ in. in diameter with a small cork borer, and putting into this a swan-shot, or a piece of the right size and length cut off a rod of lead. By striking this on each side it can be riveted so as to remain in position. By proper adjustment of the thickness of cork and the amount of lead, the artificial blood corpuscles may be made to float upright in the water, and either to remain partially or totally submerged. This method of imitating the formation of rouleaux by blood corpuscles artificially is due to the late Professor Norris of Birmingham, who, in a paper read before the Royal Society, May 27, 1869, showed that artificial blood corpuscles partially submerged quickly run together and form rouleaux. If totally submerged they remain indifferent, and do not seem to attract one another. If, however, they are dipped in petroleum, so that they are not wetted by water, they run together even though they are submerged. These facts are no doubt due to alterations in surface tension. It occurred to me that if the cork discs were covered with soap, so as to be readily wetted by water, they would remain indifferent, but if the water were acidulated the surface of the coating of soap would be decomposed, and a thin layer of fatty acid formed, which would not be wetted by the water. The corpuscles should then tend to form rouleaux, exactly as though they were wetted with petroleum, as in Norris' experiment, and on testing this I found the corpuscles behaved exactly as I had expected. On trying the same thing with wooden matches, to imitate bacteria, I found that they behaved like the artificial corpuscles, with this difference, that they formed clumps instead of rouleaux. From this experiment it seems probable that the formation of rouleaux by the red blood corpuscles and of clumps by bacteria is due to some slight alteration in their surfaces, and this may not improbably be due to the liberation of some fatty substances by means of carbonic acid. In the case of typhoid bacilli the formation of clumps is a complex phenomenon, depending first on the death of the flagella which render the bacilli motile, and thus tend to keep them apart, in spite of any addition to their surfaces; and, second, to alteration in their surface tension, which tends to produce clumping. It is not improbable that the presence of carbonic acid may have a good deal to do with the formation of rouleaux by blood corpuscles and with the clumping of bacilli.

ON THE PRESENCE OF A GLYCOLYTIC ENZYME IN MUSCLE.

IN CONJUNCTION WITH HERBERT RHODES, M.B.

(From *Proceedings of the Royal Society.*)

Received May 7th—Read May 23rd, 1901.

It was found by Claud Bernard as well as by Ludwig and Genersich that the blood which issued from a contracting muscle contained less sugar than the arterial blood which entered it. This destruction of sugar during its passage through the muscle might no doubt be partially due to the action of the blood itself upon the sugar, but it is natural to think that it may be due to the action of some glycolytic ferment contained in the muscle itself. An attempt to isolate such a ferment or enzyme was made by one of us (Brunton) in 1873. The attempt was only partially successful. The method employed was that of von Wittich. Some fresh muscle was comminuted, thoroughly mixed with glycerine and allowed to stand for many days. The glycerine extract was then filtered off. When some of this extract was mixed with a solution of glucose and allowed to stand for some hours at a temperature of the body, a distinct diminution was observed in the amount of glucose, while a control specimen of the glucose treated in the same way with a similar quantity of pure glycerine showed no diminution. The presence of a glycolytic substance was thus clearly shown. An attempt was made to isolate a glycolytic enzyme from the glycerine extract by diluting the glycerine and mixing it with alcohol. A scanty white precipitate was obtained, but the precipitate exhibited little if any glycolytic power. Numerous experiments having failed to isolate the ferment, they were not published, and the result was only briefly noticed (p. 34) in a foot-note on a paper on Diabetes in the *British Medical Journal* of February 21, 1874. At that time, one of us (Brunton) administered raw meat to diabetic patients in the hope of supplying

sufficient glycolytic ferment to enable the sugar to be better utilised in the body, and also tried the administration of glycerine extract of muscle. The success attending these attempts was not, however, sufficient to encourage the persistent use of this means of treatment, and the attempt to isolate a glycolytic ferment was abandoned for a good many years. The success of Buchner in separating an alcoholic ferment from yeast by means of great pressure gave promise of possible success in separating a glycolytic ferment from muscle by similar means, and by the kindness of Messrs. Allen and Hanbury, who allowed us the use of their hydraulic press, with a pressure of five tons to the square inch, we were enabled to resume the research. The following was the method adopted: The bone and superfluous fat were removed from the muscular part of a newly-killed sheep. The muscle was then minced in a sterilised sausage machine and pounded in a mortar with silver sand. The silver sand was previously cleaned by means of hydrochloric acid and washing with water until all the hydrochloric acid had been removed. The mass was then put into a canvas bag and placed under the hydraulic press. The juice was received into clean, stoppered bottles, the portion which was yielded at different pressures being received into different bottles. The quantity of juice obtained from a leg of mutton was as follows:—

1750 grammes of flesh yielded approximately—

At 0·1 ton pressure	per sq. inch	... 450 c.c.	of juice.	
„ 1·2 tons „	„	... 350 c.c.	„	[additional]
„ 2·5 tons „	„	... 125 c.c.	„	[additional]

The method of experiment was as follows:—5 c.c. of the muscle-juice were placed in a flask and boiled for one minute, 5 c.c. in another flask remained unboiled. To each flask 50 c.c. of a 1 per cent. solution of diabetic sugar and 5 c.c. of a 1 per cent. solution of lactic acid, with a fragment (about 0·25 gramme) of thymol were added. Both vessels were incubated at 37° C. for 24 or 48 hours. After the incubation was finished the sugar was estimated in both flasks by titration with Fehling's solution, after precipitation of the albumin by boiling and neutralisation if required. Six experiments were done with concordant results, and we have only given the result of one as being typical.

Sugar as estimated by reduction of Fehling's fluid—

1st sample	A (boiled juice)	48 hrs.' incubation	0·57	per cent. dextrose.
2nd ,,	B (unboiled juice)	,, ,,	0·2	,, ,,

The destruction of sugar in the flask containing unboiled sugar seemed to be almost certainly due to some glycolytic enzyme, as the contents of the flask remained quite clear at the time of experiment. Later on, however, the contents of the unboiled flask became turbid, and after four days a definite growth of fungi was obtained. We next attempted to render the muscle-juice sterile by a Pasteur-Chamberland filter. The sugar solution was sterilised by boiling and all the flasks and other vessels used in these experiments by heating in an autoclave. The muscle-juice after filtration was completely sterile, as was shown by the fact that it was kept in a bottle plugged with sterilised wool for many weeks without any bacterial growth exhibiting itself. The glycolytic power of this sterilised muscle-juice was tested in the following manner: 5 c.c. of the sterilised juice was placed in each of two flasks. In one of them the juice was boiled so as to destroy any glycolytic ferment it might contain. Into each flask we then placed 30 c.c. of a 2 per cent. sterile solution of diabetic sugar. They were incubated for forty-eight hours. The amount of sugar in each flask was then ascertained by titration with Fehling's solution in the same way as before, and the result obtained was 1·5 per cent. of diabetic sugar in the flask containing boiled meat-juice, and only 0·75 per cent. in the flask containing unboiled juice. A very distinct glycolytic action is thus shown by this experiment which was repeated three times with identical results.

A number of experiments were now made to isolate an enzyme by dialysis through membranes consisting of sausage skin or parchment. In the first series a distinct glycolytic action was observed, but this was probably due to bacterial action as the media became turbid, and in a subsequent series made with antiseptic precautions no glycolytic power was observed in the dialysate, although a flocculent precipitate resulted on the addition of absolute alcohol.

An attempt was made in another series of experiments to isolate the glycolytic ferment of muscle itself by precipitation. These were not successful. Fresh juice was mixed with four times its volume of absolute alcohol, the precipitate was collected, dried and pulverised. It was then extracted with glycerine, but this extract had little or no glycolytic power. It gave a white flocculent precipitate with absolute alcohol, which was soluble in saline

solution, but which was quite without any glycolytic action whatever. The action of muscle-juice was also tested on neutral diabetic urine and on a neutral solution of commercial dextrose. The results were as follows:—

Flask C contained 2 c.c. boiled muscle-juice and 10 c.c. neutral diabetic urine.
„ D „ 2 c.c. unboiled muscle-juice and 10 c.c. neutral diabetic urine.

After 50 hours' incubation at 37° C.,
C contained 1·25 per cent. of dextrose.
D „ 0·75 per cent. „

Flask E contained 2 c.c. boiled muscle-juice, 10 c.c. neutral diabetic urine and 1 c.c. of a 1 per cent. solution of lactic acid.
„ F „ 2 c.c. unboiled juice, urine, and lactic acid as E.

Again after incubation,
Flask E contained 2·5 per cent. dextrose.
„ F „ 0·5 „ „ „

Flask G contained 2 c.c. boiled muscle-juice, 10 c.c. neutral solution of 0·5 per cent. commercial dextrose.
„ H „ 2 c.c. unboiled muscle-juice, the rest as G after incubation.
„ G „ 0·37 per cent. dextrose.
„ H gave no reduction with Fehling's solution.

The experiments that we have described prove, we think, that muscle certainly contains a glycolytic enzyme, though it is of such a delicate nature that we have not been able to isolate it without destroying its power.

ON THE MEDICAL TREATMENT OF DISEASE.

A Clinical Lecture delivered at the Medical Graduates' College and Polyclinic, Chenies Street, April 10, 1901.

(From the *Clinical Journal,* April 24, 1901.)

GENTLEMEN,—I confess that until within ten days ago I did not know myself what the subject of my lecture to-day was to be. But I happened to get a pamphlet sent to me from the Polyclinic announcing that this lecture had been fixed for to-day, and that the subject of it was to be "The Medical Treatment of Disease."

The most extraordinary lecture I ever listened to was one given by the late Professor Balfour, of Edinburgh. In this lecture he discussed the whole subject of botany, beginning with the vegetable cell, passing through the natural orders, and finishing up with the geographical distribution of plants and fossil botany—all in the space of one hour. I do not think I can attempt any feat of the sort, and if I did attempt it I should certainly not succeed. And yet you may think that I am attempting very little else in this lecture, having as its subject "The Medical Treatment of Disease." But I do not intend to give you the whole medical treatment of disease, because it would be perfectly impossible to do so in the time at my disposal; all that I intend to do is to give you some thoughts about the general relationship of the treatment of disease by drugs to the treatment of disease by other methods, and to insist upon one or two little practical points that I think are sometimes not sufficiently attended to.

You all know that some years ago there was a phase of medical scepticism, during which it was rather the fashion for some medical men to say, "*I* do not believe in drugs," and to pooh-pooh those who did. But this scepticism was not entirely satisfactory to the patients, because the reason why patients consult us nine times out of ten is that they want us either to relieve or to cure the

diseases from which they are suffering, and if we cannot do this, they think it is not much good having us in.

Though unsatisfactory in itself, this scepticism was not without its good side, for it was the reaction from the meddlesome medicine of a previous period. Oscillation, or revolution, which may be regarded as a form of oscillation, is the movement *par excellence* of all things in this universe, whether they be molecules, worlds, or phases of thought. A reformer rarely succeeds in removing an abuse unless he goes to the other extreme, and medical scepticism was an almost inevitable step from mischievous meddling based on ignorance and fancy to successful treatment based on real knowledge. You all know the comparison of a doctor to a policeman who interferes between a burglar and the citizen whom he is attacking. The well-intentioned policeman draws his truncheon, and hits hard at somebody. In the dim light he sometimes hits the citizen, sometimes the burglar, and it is a mere matter of chance whether he does harm or good. Disease is the burglar, the patient is the citizen, and the doctor the policeman who, by using powerful measures, may sometimes put a stop to the disease, but may sometimes, alas! hurt or even kill the patient.

In the dim light of empirical knowledge there can be no doubt that the physician sometimes did much harm, and the excessive use of mercury and blood-letting hurt or killed many a patient. But the light of increasing knowledge lessens day by day the risk of hurting the patient, and increases the likelihood of destroying the disease. Witness the effects of antiseptics. Antiseptics almost without exception are harmful, and in sufficient quantity destructive not only to the microbes which produce disease, but to the delicate protoplasm of the cells which compose the various tissues and organs of the human body. And yet not only the medical profession, but the public at large knows how diseases due to microbes may be prevented, controlled, or cured in a way that is little short of miraculous. Compare the feelings of people in a large city now with what they were three and a half centuries ago when a case of plague was said to have occurred. Then there was panic and terror; now there is no doubt some anxiety, but it is relieved by the knowledge that we have not to fight without weapons against an intangible pestilence, but against an invasion of microbes which we can certainly destroy by antiseptics if we only can get them applied fully and freely enough. Even when pathogenic microbes are not destroyed by antiseptics, they may be

so much weakened as to have no power to resist the attacks made upon them by the living cells of the tissues in our bodies. For the struggle for existence between the organism and pathogenic organisms is a real fight, and may be very fairly compared to one between a citizen and a burglar. Returning to this illustration, we can readily see that if the policeman even without hurting the burglar can distract his attention, and give the citizen time to rest and draw breath, he will aid him greatly in the struggle; and if he could give him a pull at a brandy flask, so much the better. Now in the struggle of the organism with disease, it must be the physician's great aim to maintain the strength of the organism by rest, food, and stimulants, quite as much as to attack the disease. The *vis medicatrix naturæ* is no empty phrase. Nature unaided may do much, but Nature aided by judicious regimen and proper medicines will do much more. But care must always be taken that the regimen and drugs are judicious, and are not calculated to do more harm than good.

Now, bodily disease is very much like national or social disturbances. You know that nations are subject to disturbances from within, civil wars, strikes, party dissensions, etc., and to invasions from without; and the same thing takes place in our bodies. Sometimes disturbance in the body arises from the want of co-ordination between the action of different parts, and sometimes it arises from the invasion of microbes from without. The first instance that I know of in which this want of relationship between the different parts of the body as a cause of disease is mentioned, is in the fable of Æsop. In this fable of "The Belly and the Members"[1] it is said that the Members took some offence at the conduct of the Belly, they called it fat and indolent, and resolved no longer to grant it the usual supplies. The Hands protested that they would not lift a Finger to keep him from starving; and the Teeth refused to chew a single morsel more for his use. But in a very short time the Members found that the Stomach was not only a highly respectable organ, but it was indispensable to their welfare, and ought to be treated accordingly. Now, we find that the usual cause of strikes is overwork, or at least that people want to work less than they do. This is very much what occurs in the body. Organs strike work because they want to do rather less than they are doing; they are as it were

[1] This fable was spoken by Menenius Agrippa, a Roman consul and general.

"put upon," and they want rest, either comparative or absolute, for a time. I do not know that there is any organ more long-suffering than the stomach, but sometimes it is treated with so little respect that it goes on strike, and then the consequences for the rest of the body are very bad. Nor do I wonder that it sometimes does go on strike; the wonder is that it does not do so oftener. I have seen a man stick his fork into a new potato bigger than a pigeon's egg, give it one gulp, and down it went; and then the man said that new potatoes were indigestible. If he had simply taken the trouble to give his teeth a fair share of the work, he would not have been troubled with indigestion. But the stomach is not a gizzard, and it will not be treated as such. If it is treated thus it is apt to strike, and one of the chief occupations of any doctor who sees much of digestive disturbances, is to insist upon the necessity of rest for the stomach by giving the teeth a larger share of the work, and making the patient eat slowly and masticate his food thoroughly. At the same time we can sometimes ease the stomach by giving less food or more digestible food, for many people eat too much, and many are too careless as to what they eat. We find also that if the stomach is weak we can give it assistance, either by helping secretion or by helping its movements. We increase its power of secretion by stimulating it before meals with a little bicarbonate of soda, perhaps along with a bitter tonic, and we give after meals a certain quantity of digestive enzymes, such as pepsin or something of that sort. But I think that very often we lose sight of the fact that secretion of the stomach—the gastric juice—will act more rapidly if you do not dilute it too much, and that it is necessary to take care that the digestive enzymes are not too much diluted. If a patient drinks much water during a meal it is evident that the gastric juice becomes diluted, and therefore digestion goes on more slowly. But the point to which I wish to draw your attention just now is this:—many patients have been told by their doctors not to drink during a meal, but they think that they may drink as much as they like immediately afterwards. But if they drink immediately after a meal they dilute their gastric juice very much as if they drank during the meal. They ought not to be allowed to drink until a couple of hours or more after the meal, until, in fact, digestion is nearly complete and the stomach is ready to empty its contents into the duodenum, and then they may take as much water as they like. But here comes another point: if the stomach

is feeble in its movements it may find a difficulty in emptying itself, and in atonic dyspepsia you may possibly find that, along with general weakness of the body, the stomach itself is feeble, and hangs down much lower than it ought to, so that instead of the food getting out of the stomach along a nearly horizontal line, it has to be hoisted up almost in a vertical direction. In order to lessen this difficulty you may give your patient directions to lie down after food for a certain length of time, say half-an-hour to an hour, or you may aid the stomach by putting on a fairly tight band. I have found a great deal of trouble in getting bands to fit the abdomen, and for this reason I frequently recommend, instead of a band made by a surgical instrument-maker, a simple strip of flannel half-a-yard broad, and doubled, so as to make a band nine inches in width, long enough to go one and a half times round the abdomen, and fastened with two or three safety pins so tightly as to give full support to the abdomen. In this way you tend to help the stomach mechanically, whilst at the same time you may stimulate its muscular fibres by the use of strychnine alone or with acids such as nitro-hydrochloric; and it is a significant fact that strychnine is one of the drugs most commonly employed in the practice of medicine.

But it is not merely rest to the stomach which we want to bring about; we frequently want to prevent the effects of invasion from without, the bad effect of microbes. Microbes in a healthy stomach have not much chance; they are soon destroyed by the gastric juice; but if the secretion of this juice be feeble, its antiseptic power is weakened, and the microbes may grow and thrive. In order to destroy them we give various antiseptics. But just consider, what is the good of pouring antiseptics in small quantities into a stomach that is full of all sorts of things? You know that in many cases where there is dilatation of the stomach, if the patient were sick he would fill a large basin with the vomit, and if you are going to put one drop of carbolic acid into a basinful of fermented liquid, is that going to stop fermentation? You say at once that it will not. In order to give your antiseptics a fair chance you must wash the stomach out first, get rid of most of your ferments, yeasts and bacteria, and if you then give your antiseptic, it will have a chance of acting.

In the intestine also we must regard both the conditions under which the intestine is placed and the drugs that we put into it. You know quite well that if we give some irritant before a meal,

for example, if we prescribe five minims of liquor arsenicalis before a meal, it is very likely indeed to bring on gastro-intestinal irritation, vomiting, and diarrhœa. If we give the same drug after meals, so that it becomes mixed up with the food, it will very likely have no local action whatever. The same thing holds good with regard to those irritants which we give for the purpose of stimulating the bowels. An old gentleman whom I knew was in the habit of taking a pill every night for at least forty years, and this acted very well. It was a very small pill, only one grain of compound colocynth pill, one of compound rhubarb pill, and one grain of extract of hyoscyamus. This acted with perfect regularity, and he thought the reason was that he gave his pill a fair chance. Instead of putting it into a full stomach he always took it about five minutes before dinner, so as to give the little pill a start of the food and an opportunity to act on the empty stomach. I have very little doubt that this five minutes before dinner made a great deal of difference in the action of his purgative, and that if he had taken the pill five minutes after dinner it would very likely not have had anything like so much effect.

Everybody knows that, however nice a food may be, people get tired of it if they always have it day after day. Partridge is a very nice thing indeed to take, but if you have partridge every day you get tired of it, and many people seem to wonder very much that the intestines should be somewhat like the palate and become tired of a single purgative, so that if it be taken night after night it ceases to have effect. If you tire of partridge you go on to some mutton, and if you tire of mutton you go on to beef. Treat your bowels in the same way as the stomach. If they are tired of cascara go on to rhubarb. If they get tired of rhubarb go on to colocynth, and from colocynth pass on to senna, and so on; and by the time you have gone the round of purgatives the bowels will be ready for the first one again. If you want to soothe the bowels instead of stimulating them, you must of course be careful about the food, and see that there is nothing irritating in it to stir up the bowels mechanically. At the same time you may often find it necessary to give some antiseptics, just as in the case of the stomach, and here again it is well to clear out the bowels first, so as to give the antiseptics or sedatives fair play. I am not going into the question of antiseptics in the intestine. They are very numerous and very useful, but I wish you to remember that we have to treat the bowels like the stomach, and like the rest

of the body too, in being careful to remove external irritants, and one very powerful irritant of the intestines is a sudden change of temperature. Many of you may remember some years ago a great discussion about electric belts; and at a trial concerning these belts a number of people said that they had got the very greatest possible benefit from them. I have no doubt they did. It was not because they were electric belts, because I think it was shown that they contained no electricity, but because they were *belts*. And sometimes in cases where you fail to get any good at all from your astringents you may find that diarrhœa may be arrested by the use of a large belt to the abdomen, and more especially by a belt made of chamois leather, made much in the same way as the flannel belts I have already described.

There are certain cases of diarrhœa which are exceedingly troublesome. They will go on for years, and you treat them until both you and the patient are sick of it; sometimes there is chronic continuous diarrhœa, sometimes, and perhaps more frequently, two or three days' diarrhœa alternating with two or three days of constipation. The motions frequently contain quantities of mucus, showing a considerable amount of catarrh in the intestine. In such cases you try a number of remedies, but many of them do not succeed. I dare say very few of you have seen tannin used for intestinal complaints; I have very rarely used it for these myself, and the reason is chiefly this: that tannin expends its energy on the stomach, and it has little left to act on the intestine. Therefore, if you are going to give tannin in any form for the intestinal trouble, it must be in a somewhat insoluble form, such as catechu or kino, so that it will act on the bowel. One is afraid to mention a new drug, lest such mention should be taken by the manufacturers, and without leave, to one's great annoyance, as an advertisement. There are some new drugs which give good results in diarrhœa, but I will not mention them by name for the reason I have just given. Amongst the older ones I may mention that small doses of copper sulphate or copper chloride, one third to half a grain, given in a pill, sometimes act very beneficially. But perhaps there is one old-fashioned drug which acts even better in cases of chronic catarrh of the colon, and that is castor oil. Many of you may know that there was a sort of endemic dysentery in Millbank Dispensary, and that at one time the late Dr. Baly was physician to the Dispensary. He tried all sorts of drugs for this dysentery, and at last he hit

upon castor oil, and used it in a mixture containing 10 minims of oil made up with mucilage of acacia and peppermint water. This mixture, if it were not for its abominable taste, is an exceedingly good thing in cases of chronic catarrh of the colon. In some cases I have given a 10-minim dose in a capsule, with one minim or two minims of tincture of opium. Sometimes where these small doses do not seem efficient, we find that a teaspoonful given every morning will do more for the chronic diarrhœa than anything else I know.

In regard to the stomach and intestine we have always to remember that the blood from these organs has to pass through the liver before it ever gets into the general circulation, and that if we are to do much good in a case of congestion of either the stomach or the intestines we must be careful that the circulation through the liver is free. The liver is a very sensitive organ, and is very liable to suffer from chills. I do not know that any organ is more readily affected by chill than the liver without the patient being aware of it. Frequently people come and say, "I do not know what I have eaten or drunk that has disagreed with me, but my digestion has gone all wrong." Very often it is not that the patient has eaten or drunk anything which is indigestible, but that he has got a chill to his feet or shins, his liver, or the back of his neck. Most frequently in such cases the person has been sitting in a draught between the door and the fire, and the chill has come about without his knowing it. Here, again, the old-fashioned remedy of five grains of blue pill taken at night and a black draught in the morning sometimes is of great benefit. This remedy is sometimes good even in cases of chronic diarrhœa. I remember very well a man who came from Assam to consult me, and he had been suffering from chronic diarrhœa for several months. His liver was large and congested, and I said to him, "There is one remedy I should like to use, but I do not like to give it without consultation. I would like to use sulphate of magnesium and blue pill, but it seems so queer to give a man a purgative who is suffering from chronic diarrhœa." I took him to Sir Joseph Fayrer, and he agreed with the diagnosis and with the treatment. We gave the man a course of blue pill and sulphate of magnesium, and the result was that his liver went down to its normal size and the diarrhœa ceased.

We have been speaking a good deal about the effect of rest to the stomach, but in cases where there is a severe lesion of the

mucous membrane, either in the stomach or in the duodenum, we find the advantages of medication. Just now, with changeable weather, I think there has been an unusually large number of cases of gastric ulcer, and this very morning I saw a lady who had been suffering such intense pain that, without stopping to ask a doctor or her husband, she had gone to consult a surgeon with the idea of having her abdomen opened and the ulcer sewn up. It happened that the ulcer was a duodenal one, and a surgical operation for its treatment would have been almost impossible. But in most of those cases you can stop the pain almost to a certainty by the simple use of bicarbonate of soda, only you must use it in large quantities. The best way is take a big teaspoonful of bicarbonate of soda, dissolve it, and let the patient sip the solution teaspoonful by teaspoonful until the pain is gone. I have said you should dissolve it, but I have not mentioned the solvent. Formerly I used to dissolve it in water, but now I almost always use lime water, and add to the lime water some spirit of peppermint. The reason I use lime water now is this. Some years ago I was called to a very severe case of duodenal ulcer, and I prescribed bicarbonate of soda. It acted like a charm as far as relieving the pain was concerned; but a little while afterwards the patient was seized with hæmorrhage, which recurred and recurred, and finally proved fatal. One knows that in severe gastric ulcer, or duodenal ulcer, hæmorrhage may occur of itself, so that I could not say it was due in this case to the bicarbonate of soda that I prescribed; but it occurred to me afterwards that the bicarbonate of soda might possibly have softened the tissues, and thus rendered the patient more liable to hæmorrhage; and ever since I have used lime in some form along with the bicarbonate of soda. Now, in cases of ulcer of the stomach or duodenum you generally find there is a good deal of constipation, so by giving lime you are tending to increase the constipation. To lessen this you may give with the bicarbonate of soda and lime water some fluid magnesia, and thus you will counteract the tendency to constipation at the same time as you neutralise the acid of the gastric contents, and you relieve the pain, sometimes as if by magic. In cases of gastric or duodenal ulcer I think you will find that neutralising the acid of the stomach and duodenum will relieve the pain even when fairly large doses of morphia have failed to subdue it.

Instead of dissolving the bicarbonate of soda in lime water, the following may be used:

℞	Spt. menth. pip. ʒ iss. *vel* Ol. menth. pip. ♏xii.		
	Cretæ præparat.	... ...	ʒ ss.
	Magnes. carb. lev.	... ...	ʒ j.
	Sodii bicarb.	... ...	℥ j.
M.	Ft. pulv.		

A teaspoonful to be mixed with half a tumbler of water or more, and slowly sipped, a teaspoonful at a time, till the pain is relieved.

Another part of the intestinal canal that is very apt to be troublesome is the rectum. Piles are a very common condition. Rest here is one of the greatest boons that you can give to the patient. The piles very often are apt to come down after a motion, and if you can manage to get the patient to go to stool in the evening instead of in the morning, it will allow the patient to rest after the process of defæcation, and allow the piles to remain in the rectum after being replaced, instead of coming out again and being subjected to friction as is likely to be the case if the bowels are relieved earlier in the day. There is a tendency in many people for prolapse of the intestine to occur not only through the anus, but also of the sigmoid into the rectum. This condition is not infrequently associated with a feeling of depression and soreness after the bowels have been opened, and here again rest at night immediately after the motion will do a great deal of good. Astringents, both to the piles and to the prolapsed sigmoid, are very beneficial, and the old-fashioned gall and opium ointment to the piles, and an astringent solution injected into the rectum and allowed to remain there in contact with the upper part of the rectum, and with the prolapsed sigmoid, will have a good effect. You may, if you like, introduce gall and opium ointment into the bowel by means of an ointment introducer for prolapse of the sigmoid, or you may not require to use opium, but may simply inject a solution of tincture of catechu, two drachms in two ounces of water, and allow that to remain in the bowel as long as the patient can retain it. But there is one very simple thing which does more to relieve piles than anything else, and that is careful washing immediately after defæcation. However carefully the fæcal matter may be wiped away from the anus in persons who are suffering from piles, a little fæcal matter is very likely to remain between the piles, and act as a constant irritant during the day. If it be carefully washed away immediately after a motion

the patient has no further trouble, and the piles are not again extruded, as would be the case if there was a little irritant matter still remaining there. Sometimes you may find that the addition of one or two per cent. of cocaine to the gall and opium ointment helps its action very considerably. Another drug which is very useful is hamamelis. You may make a mixture of half-an-ounce of gall and opium ointment, and half-an-ounce of ointment of hamamelis or similar proprietary preparations, with enough cocaine added to make a 1 per cent. ointment. This gives great relief in many cases of piles (cf. *antea*, p. 306).

Another part of the body which is very much tried just now by the changeable weather is the throat and larynx. You find many people suffering at the present time from very severe colds. We all know that the cough which accompanies a cold is due to reflex irritation, and this irritation is generally in the trachea, bronchi, or lungs. But the irritation in these places may not be sufficient in itself to produce cough, yet it will do so if it be supplemented by irritation from somewhere else. And thus we have what is known as stomach cough. Irritation of the stomach does not cause cough, but irritation of the stomach *plus* irritation in the trachea or bronchi may cause it. You may ease such a cough by giving simply bicarbonate of soda in much the same way as I have recommended in cases of gastric ulcer. I have been inclined to think, from my experience within the last few weeks, that there is another additional cause of cough, namely, irritation at the back of the nose. Sometimes you get irritation of the back of the nose with a certain amount of mucus forming there, and a cough which comes on severely, and is not stopped merely by treating the larynx or the trachea, but is lessened by clearing out the mucus from the naso-pharynx. Where there has been irritation of the larynx I have been using paroleine a good deal, with 1 to 2 per cent. of cocaine, and 3 or 4 per cent. of menthol. This not only gives good results for the nose and for the back of the throat, but is useful also in cases of irritation in the larynx.

Another remedy by means of which one can stop laryngeal coughs, which have, I think, been more usually common of late, is a spray directed on to the larynx itself. There are various substances as sprays which act perfectly well, but a spray containing 1 per cent. of morphine, or a similar quantity of heroin, which is a new and apparently a useful preparation, or

1 per cent. of cocaine, either alone or combined with morphine, tends to ease the cough for the time being, and to stop the tremendous spasm which comes on. In these cases of throat cough there is very often a certain amount of hoarseness. The cough is exceedingly violent, and nothing seems to stop it, and yet little or no expectoration comes away. If you look into the throat the vocal cords are congested, and perhaps a little thickened, and possibly not meeting so well in the middle as they should do. But there is nothing more to be seen. For these cases the local application is, I think, better than the general use of morphine, which tends rather to interfere with digestion.

In the case of every organ of the body we find that rest is one of the greatest boons when disease is present, and I do not think I have ever done so much good by any drug in cases of cardiac disease as I have done by prescribing rest. It is one of the hardest things in the world to get that prescription carried out, because many of the cases are in men who have been accustomed, not only to work hard themselves all their lives, but to drive everybody else round, and you cannot get it into their heads that they must remain quiet now. There are two things which it is very hard to get men to do; it is very difficult to get a lazy man to work, but it is still harder to keep an energetic man quiet. In cases of cardiac disease rest is, I think, above all things the panacea. But rest alone will not do everything you want, and one must use along with it various remedies. The chief ones are strychnine to stimulate the heart, and digitalin to increase its power; but we must remember in using those drugs that the heart may be somewhat degenerated, the fibres may be somewhat fatty, and if we use these drugs we tend to increase the contractile power of the vessel, and to oppose a greater resistance to the heart. Therefore we may sometimes find that instead of doing good we are doing harm. How are we to meet this difficulty? I think we may meet it to a considerable extent by giving at the same time some drug that will tend to dilate the vessels. And so instead of leaving the patient to himself you may prescribe, along with rest, digitalis or strychnine, and possibly some caffeine also; but combine these with spirit of nitrous ether, with nitro-glycerine, or nitro-erythrol. Thus, at the same time that you are causing increased contraction of the heart, you are dilating the vessels, and so in every way accelerating the circulation of the blood. But we must never forget that in cases of heart disease

the condition of the blood has very much to do with the cure of the patient, and when the ordinary method of treatment fails entirely one may sometimes succeed by coming back to the old-fashioned plan of giving one grain of blue pill, one grain of powdered digitalis, and one or two grains of powdered squill three times a day. I have had a patient under my care lately, suffering from very bad mitral regurgitation as well as mitral obstruction, with a great deal of œdema, and, other drugs having failed, we have put the girl upon this old-fashioned pill, and continued it longer than one usually does,—so long, in fact, that we began to get the well-known action on the gums. And, curiously, it was just when the action of the mercury began to be manifested by soreness of the gums that the œdema began to distinctly subside. This is an observation that is in accordance with what one reads in the old books; but at the present day we do not, as a rule, push mercury so far. I believe that very often if we were to push our drugs, especially mercury, a little further, in the way our predecessors did seventy years ago, we might sometimes get better results.

Another remedy that has recently been introduced is one which I wish to bring before your attention. Many of you have probably used it largely, and it may not be new to you. I refer to urotropine, as a remedy both in cases of cystitis and also in cases where you wish to disinfect after typhoid fever. Not very long ago Dr. Horton Smith showed that the urine of typhoid patients contained large numbers of typhoid bacilli, so that a new channel of infection was pointed out by him. Before that, one had been accustomed to regard the fæces as being the chief channel of infection; but now we know that urine, either coming accidentally in contact with the utensils or lying upon sheets, may be a means of conveying infection, and if you put such patients upon urotropine you may remove one chance of infection. Therefore now, as a matter of routine, we have been accustomed to give urotropine towards the end of an attack of typhoid fever in order to destroy the infectiveness of the bacilli, these having been found to be present and to be infective after the fever is practically terminated. In cases of catarrh of the bladder there is no drug like it, but I think it is often given in too small doses,—for instance, five to seven grains; whereas, if you want to get the best results, I think you must give it in doses of ten grains or more. When the larger doses are given I have seen no bad results, but I think

you may often get distinct advantage with a large dose when you fail with a small one.

The only other point I would draw your attention to is the effect of rest, combined with certain drugs, in nervous exhaustion and brain fag. Everybody is accustomed to have his night's rest in order to prepare for the work of the succeeding day. But many people do not seem to consider that the night's rest is not always sufficient to recuperate from the work of the preceding day, and to render the person properly fit for the work of the succeeding day, and that therefore there is a little residuum of weariness over. In many people this residuum becomes very definite towards the end of the week, so that they feel worn out, and they want one whole day in which to rest themselves. If they do not take that rest they break down in consequence. I do not know that this is so evident in any other class of people as it is amongst clergymen; and the reason that so many clergymen break down is that they do not keep the fourth commandment, "Six days shalt thou labour and do all thou hast to do:" but the clergyman does not do this, and on the seventh day, when he ought to be resting as well as everybody else, he is working hardest. Now, if you have any clergymen to treat, insist that they shall keep the fourth commandment. It is not one day in seven or two in fourteen which will do, but every seventh day; the seventh day must be the day of rest, so that the day of rest is regularly recurring. Clergymen, as a rule, cannot take Saturday, but insist upon their taking Monday if they have to work hard on Sunday. But Moses showed his wisdom in another thing. He knew that even the seventh day was not sufficient sometimes. He knew there might be a residuum, and so he ordained a year of rest every seventh year. The Americans show their wisdom in this. American professors get a year off every seven years, during which period the work of the Professorship is taken by an assistant, while the Professor himself goes away and recuperates, and at the same time learns all that is going on, so that he goes back fresh in mind and knowing a great deal more than he did when he left, and so the students reap the advantage. Now it is very odd that there are so many people who will not take rest, although nature seems to be pressing it upon them. You will find patients coming and telling you that they are always tired, and that they would like to sleep week in and week out. If you tell them to go to bed for a week they will think there is nothing nicer, but they will not do it

until the doctor tells them to do so. Then they will go to bed, have a thorough rest, and recover. But rest is merely good in one way, in so far as it allows the tissues time to recover; but sometimes it is bad in another way, in so far that the quietude may tend to allow the products of waste to accumulate, and so occasionally you may not only have to insist upon rest so as to recuperate, but you may have to remove the products of waste by massage. And where other methods have failed you can have recourse to the method introduced by Weir Mitchell and known by his name, of complete rest of body and mind, forced feeding and massage. In the cases which are not quite so bad as this you get somewhat the same result by a long sea voyage, for then the patient is resting, is unable to get much exercise, while the continued motion in the open air gives him an appetite. Moreover, he is isolated from telegrams and letters, or intrusion of any kind, and thus there is rest of the mind. But sometimes patients cannot go through the Weir Mitchell treatment or have a long sea voyage, and then you may have recourse to drugs. There is one combination of drugs which I have found very satisfactory, and which I give very frequently, and that is a mixture of bromide of potassium and salicylate of soda.[1] The reason this mixture is so useful is, I think, simply that the bromide quietens the nervous system down, whilst salicylate tends to remove the waste products. If you are going to sweep out a room you have two things to do; you have to apply the besom, and sprinkle water so as to prevent the dust from rising too high. That is what you do in giving salicylate of soda and bromide of potassium; the besom is the salicylate to clear out the waste products, and the bromide of potassium is the damp which quiets the nervous system.[2] Therefore the two combined are exceedingly good, not only in preventing or removing headache, but in preventing what is sometimes of the very greatest trouble to the patient and his friends, irritability of temper. And I feel quite sure that each one of you must require a dose of both of those drugs after having listened to such a long lecture, with a patience for which I cannot thank you too warmly.

[1] *Vide* p. 320. [2] *Vide* p. 420.

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THE END

Richard Clay & Sons, Limited, London and Bungay.